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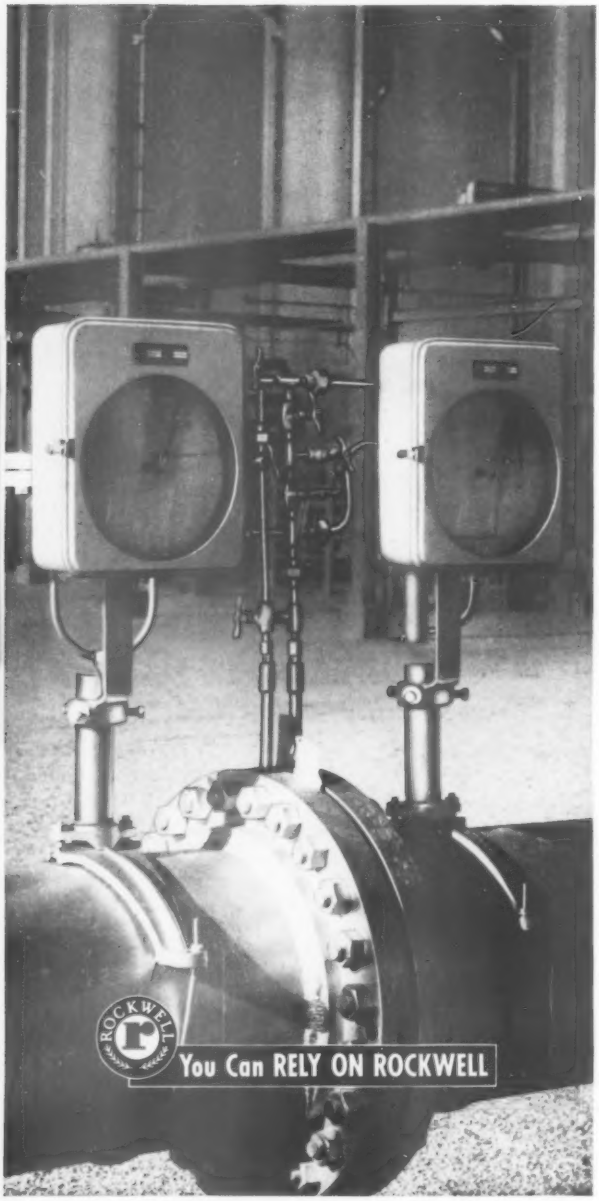
PRICE 50 CENTS TABLE OF CONTENTS ON PAGE 1 MARCH 23, 1953

# ROCKWELL "201" Orifice Meters

**SERVICE EASE**
**ACCESSIBILITY**
**FLEXIBILITY...** *SAVE YOU MONEY!*




In Rockwell orifice meters you get the convenience of a design that can quickly be dismantled or assembled using common, everyday tools. You get the economy of a unit manometer construction which enables you to interchange the high side chamber with other chambers of higher or lower range so as to adapt the meter to varying field conditions. You get a better design incorporating stronger, corrosion-resistant parts, a Teflon stuffing box and other quality features that pay dividends in the form of sustained meter accuracy and longer meter life. You'll gain *all* these advantages when you use Rockwell orifice meters on *all* your services. Write for bulletin 1050.

## ROCKWELL INTEGRATOR

**MATCHES RECORDED ACCURACY WITH COMPUTED ACCURACY**

This office machine precisely calculates the extension of orifice meter charts by directly tracing the static and differential records made by the meter in the field. One operator can handle up to 300 average charts a day. Ask for bulletin 1016.

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the OIL AND GAS JOURNAL

MARCH 23, 1953 VOL. 51 NO. 46

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## In Brief...

**MULTICOMPONENT DISTILLATION** . . . Procedures for designing and checking distillation column performance are outlined in detail and illustrated where necessary. In addition to the theory of tray calculations, methods are also given which take into account liquid and vapor loading, tray layout, and riser and downcomer design and sizing.

**REFINERY MAINTENANCE** . . . There are a number of ways in which the refiner can cut his maintenance costs. These include: (1) new work methods; (2) use of mobile equipment; (3) setting up a refinery-wide maintenance coordinating committee; (4) proper evaluation of standby equipment and spare parts; and (5) how to prevent erosion and corrosion at critical points in the refinery.

**NEW REFINING DEVELOPMENTS...** Perhaps the three aspects of processing petroleum of most interest to refiners at this time are catalytic reforming, catalytic cracking, and processing heavy residuum. These subjects are dealt with in the special refining section. In addition, the Journal's refining editor has written roundup stories on these subjects for the news section.

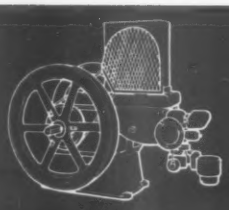
**REFINERY PROCESSING TABLES** . . . These tables on North American Operating Refineries have been expanded this year to include the specific types of refining processes, as well as the general process category. More than twice as much detailed information is now made available.

**REFINERY CONSTRUCTION** . . . This annual Journal feature is continued this year to show what additional refining capacity will be added by North American refineries in the near future.

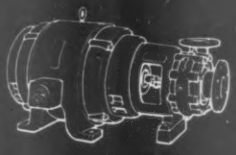
# For More in Oil Field Equipment

## it's FAIRBANKS-MORSE

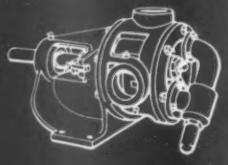
Electric Motors



ZC Engines



Builtogether Pumps



Rotary Pumps



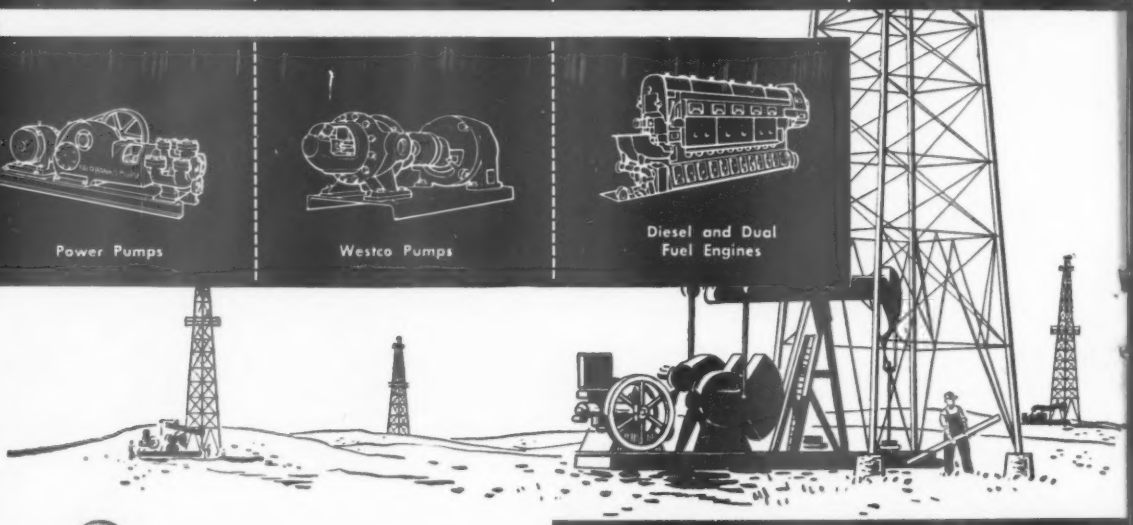
Power Pumps



Westco Pumps



Diesel and Dual Fuel Engines



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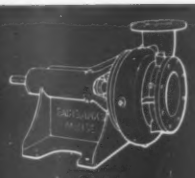
Single and Two-Stage Centrifugal Pumps



Side-Suction Centrifugal Pumps

# New Fuel Oil Additive Announced by Du Pont

EFFECT OF F.O.A. NO. 2 ON SCREEN CLOGGING
F.O.A. NO. 2 ADDED PRIOR TO AGING
CONTROL
0.010 WT. % F.O.A. NO. 2
OIL A AGED 6 MONTHS AT 110°F IN DARK
CONTROL
0.020 WT. % F.O.A. NO. 2
OIL B AGED 9 MONTHS AT ROOM TEMPERATURE

**THESE FOUR FILTER SCREENS** show clearly the improvement in two oils to which Du Pont Fuel Oil Additive No. 2 was added.

**Customer complaints on plugged filters, screens and fuel lines may now be eliminated through use of Du Pont Fuel Oil Additive No. 2**

Du Pont Fuel Oil Additive No. 2 was developed as a dispersant and stabilizer for distillate fuel oils. Such oils tend to deteriorate during long-term storage, resulting in the formation of insoluble residues which cause clogging.

**TO PREVENT CLOGGING,** Fuel Oil Additive No. 2 not only retards the formation of insoluble residues, but also reduces the particle size of those insoluble residues that are formed.

With the new additive, catalytic cracked stocks of the proper boiling range can be blended with straight-run products without sacrificing stability in the blend.

This means greater flexibility to meet seasonal demands, increased yield of domestic heating oils, and release of straight-run stocks for premium diesel fuel or for charging stock.

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**HIGHLY EFFECTIVE,** Du Pont Fuel Oil Additive No. 2 gives desired results at lower cost.

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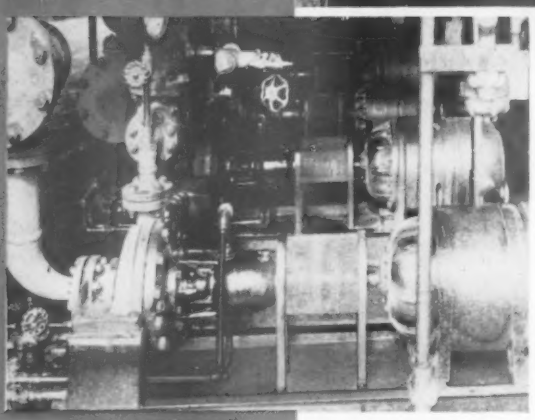
# *Pumping Jobs are Different...*

**but your maintenance inventories stay small, when you standardize on**

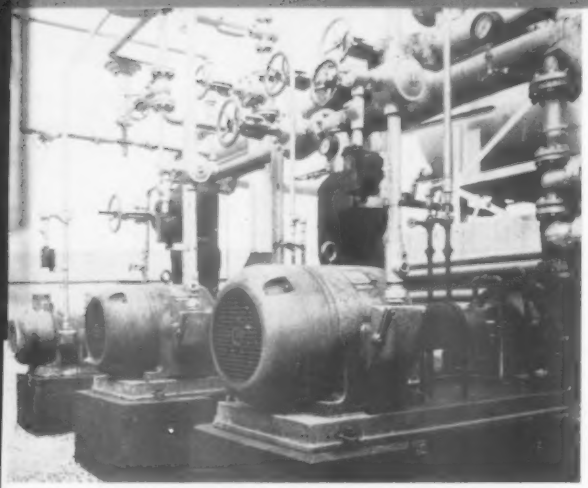
## Wilson-Snyder Type ES Process Pumps

Three pumps are in the "Cat Cracker" feed preparation section. They handle gasoline with sp. gr. .742 at 100°F temperatures at differential pressures from 75 to 150 psi—yet each pump capacity is 137 gpm.



Three more pumps in service in the "Gas Recovery" section handle both gasoline with sp. gr. .661 and lighter and butane with sp. gr. .587 and lighter at the rate of 140 gpm and at pump temperatures of 100°F. Differential pressures for different pumps range from 75 to 165 psi.

These seven "product pumps" directly beneath the main "Cat Cracker" section handle hot oil at temperatures ranging from 400°F to 800°F. Pumps in the bank operate independently of each other and differential pressures range from 75 to 210 psi—capacities from 100 to 535 gpm.



GREAT LAKES Refining Division of Petco Corporation near Chicago, Illinois, has thirteen Type ES Centrifugal Process Pumps in three distinctly different process service applications—each of which presents different operating conditions and calls for different combinations of capacities, differential heads, specific gravities, etc. The description by each picture tells the story.

But what the engineers of this refinery discovered was this: In addition to the broad capacity range at high efficiency and the extra long service life provided in the Type ES pump design . . . only three sizes of bearing brackets, sleeves, packings, shafts and bearings are required for servicing all 18 pump sizes in the line.

This enables refineries to standardize on these pumps for most types of operations where capacity ranges are from 40 to 1800 gpm, with differential heads from 40 to 1000 feet, with speeds ranging from 1750 to 4000 rpm and with horsepower ranges from 2 to 250. Extra savings result from the amazingly small inventory of maintenance supply parts required.

***FOR FULL INFORMATION . . . or quotations on Wilson-Snyder Process Pumps, contact "Oilwell's" nearest refinery specialist at area office points shown at left.***

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# GET BOTH { CAST STEEL GATE VALVES AND LUBRICATED PLUG VALVES

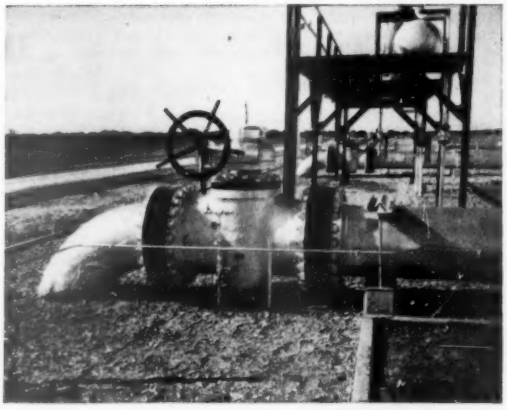
## made by Walworth...for crude, finished products, and gas pipelines

It's the old, old story . . . one source of supply, one order, and one responsibility! It's as simple as that . . . and it's that simple because Walworth – one of the world's outstanding valve manufacturers – and only Walworth, makes both Cast Steel Gate Valves and Lubricated Plug Valves for pipeline service.

### WALWORTH TYPE 49 CAST STEEL GATE VALVES

Designed on the through-port principle . . . body and disc ports are accurately indexed . . . body ports bored to match connecting piping . . . no obstructions to interfere with free flow of liquid or the passage of pigs or scrapers . . . no recesses to accumulate dirt . . . no internal lubrication required. These valves may be installed without regard to flow direction. Sizes: 2 to 30 inches, inclusive. Series 400 and 600 for working pressures up to 1440 pounds per square inch.

Walworth 30-inch, Type 49, Cast Steel, Pipeline Gate Valve installed in a gas line.



Walworth 24-inch, Cast Steel, Lubricated Plug Valve on discharge line in gas booster station.

### WALWORTH LUBRICATED PLUG VALVES

Features include: quick opening and closing with quarter-turn of plug . . . no threaded stems or complicated seating mechanisms . . . plug is always seated in the body . . . foreign matter cannot wedge between seating surfaces . . . lapped surfaces of both plug and body, plus lubricant seal, assure tight, leakproof closure. Made of steel, iron, bronze, or special alloys. Sizes: ½ to 30 inches, inclusive. Working pressures: 125 to 5,000 pounds per square inch.

• • •

Both the Walworth Type 49 and the Walworth Lubricated Plug Valves have many more outstanding features. Ask your Walworth distributor to tell you about them or write Dept. 07 for illustrated circulars.

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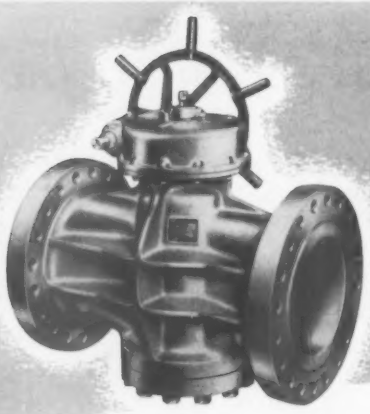

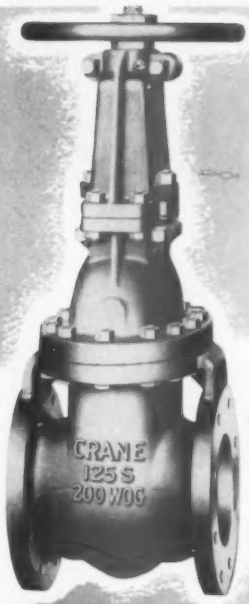


# Vinson for valves

**NORDSTROM VALVES**

Ask for our Valve Inventory Bulletin. Save time and speed up delivery of needed valves by using the Vinson Valve Inventory. You can see at a glance, what valves we have in stock . . . your answer to quick procurement of hard-to-get valves. Call or write Vinson today and ask to be put on the Valve Inventory mailing list.

**CRANE VALVES**

Vinson's four warehouses carry Crane and Nordstrom valves in practically all sizes and pressure ratings for oil and industrial users in the Southwest. Crane valves are recognized leaders in the oil industry, and are stocked in iron, brass and steel—Nordstrom valves, the pioneer lubricated plug valves, are stocked in iron and steel.

**OTHER VINSON LINES:** Ladish Welding Fittings and Flanges • Fisher Controls • Chase Brass Tubes • National Pipe and Steel Tubes

**Vinson Supply COMPANY**

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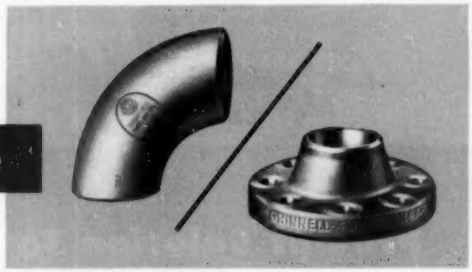
DALLAS
ODESSA
AMARILLO

for trouble-free service



# GRINNELL

## STAINLESS STEEL WELDING FITTINGS and FLANGES

To help combat mounting costs in the installation and maintenance of piping systems where corrosive or certain other service conditions are involved, Grinnell offers a comprehensive range of welding fittings and flanges in stainless steel.

- **To prevent corrosive attack.**
- **To obtain adequate impact resistance at low temperatures and sufficient creep strength at high temperatures.**
- **To provide sanitary conditions.**
- **To avoid contaminating the product.**

Grinnell welding fittings and flanges are available in types 304, 347 and 316. These are in the chromium-nickel grades known as "18-8". The corrosion resistant properties of stainless steels are primarily due to the chromium content which ranges from 17% to 20%. The addition of nickel in ranges from 7% to 14% improves the corrosion resistance as well as the properties at elevated temperatures. A molybdenum addition of 2% to 3%, as found in type 316, increases the resistance to sulphurous and phosphoric acids, brine and hypochlorite solutions, and improves the general resistance to other corrosive liquids, as well as improving the physical properties at elevated temperatures. A columbium addition of approximately 0.4% to 1.0%, as found in type 347, creates non-susceptibility to carbide precipitation which can cause intergranular corrosion.

In addition to stainless steel, Grinnell offers welding fittings and flanges in carbon steel, nickel, Inconel, Monel, aluminum and brass.

*Write for new booklet giving complete data on Grinnell stainless steel welding fittings and flanges. No obligation.*

### stainless steel welding fittings
**Types 304, 347, 316**

| DESCRIPTION | SCHEDULE† | PIPE SIZE, IN.‡ |
|---|---|---|
| 90° Long Radius Elbow<br>45° Long Radius Elbow<br>180° Long Radius Return<br>Straight Tee | 5s, 10s, 40s, 80s | ½ to 12 |
| Reducing Tee | 5s, 10s, 40s, 80s | ¾ to 12 |
| Cross (Straight and Reducing) | 5s, 10s, 40s, 80s | 1¼ to 12 |
| Concentric Reducer<br>Eccentric Reducer | 5s, 10s, 40s, 80s | ¾ to 12 |
| Lateral (Straight or Reducing) | 5s, 10s, 40s, 80s | 1 to 12 |
| Cap | 5s, 10s, 40s, 80s | ½ to 12 |
| Lap Joint Stub End-Long | 10s, 40s, 80s | ½ to 12 |
| Lap Joint Stub End-Short | 5s, 10s, 40s, | ½ to 12 |

*† 5s is Featherweight, 10s Lightweight, 40s Standard, 80s Extra Strong.*
*‡ Larger sizes available on special order.*

### stainless steel flanges

**150 lb. and 300 lb. Steel Flange Standard** *(Higher series available on application).*

| DESCRIPTION | PIPE SIZE, IN. |
|---|---|
| Welding Neck<br>Slip-on<br>Lap Joint<br>Threaded<br>Socket Type<br>Blind | ½ to 24 |

**150 lb. Corrosion Resistant Standard.** *(For use with schedule 10s and 5s pipe. Rated at 150 psi at 500°F, 225 psi at 150°F, when used with full-faced gaskets).*

| DESCRIPTION | PIPE SIZE, IN. |
|---|---|
| Buttwelding<br>Slip-on<br>Blind | ½ to 12 |

# GRINNELL
**WHENEVER PIPING IS INVOLVED**

Grinnell Company, Inc., Providence, Rhode Island • Coast-to-Coast Network of Branch Warehouses and Distributors

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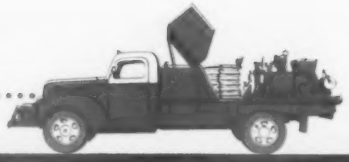
industrial supplies • Grinnell automatic sprinkler fire protection systems • Amco air conditioning systems



**Prompt Solution To Many Well Problems!**

# HALLIBURTON'S *versatile*

## DUMP BAILER SERVICE

Two factors are of prime importance in remedial well work. Time, and a satisfactory solution.

Halliburton's all-around Dump Bailer Service provides the answer to certain of these urgent remedial well problems . . . at a definite savings in time and with satisfying results.

**THE DUMP BAILER PERFORMS THE FOLLOWING MAIN TYPES OF SERVICES:**

- Places Cal-Seal, the quick-setting, almost universally-used cement for covering the top of shots for a tamp.
- Plugs back the bottom of the well where excess hole is not desired.
- Runs in the Halliburton bridging basket that can be set, opened, and dumped into simultaneously by picking up on the bailer.
- Places a Halliburton solution down well in large enough quantities to cover securaloy pipe in the casing string . . . and remove it within eight hours — replacing the old method of drilling out the pipe.

Halliburton's Dump Bailer Service also is utilized to place Resinite Seal, Resin-Cement, Hydromite, Howcogel, and Howco Sand-Lac—specialized products that perform specific tasks in remedial work.

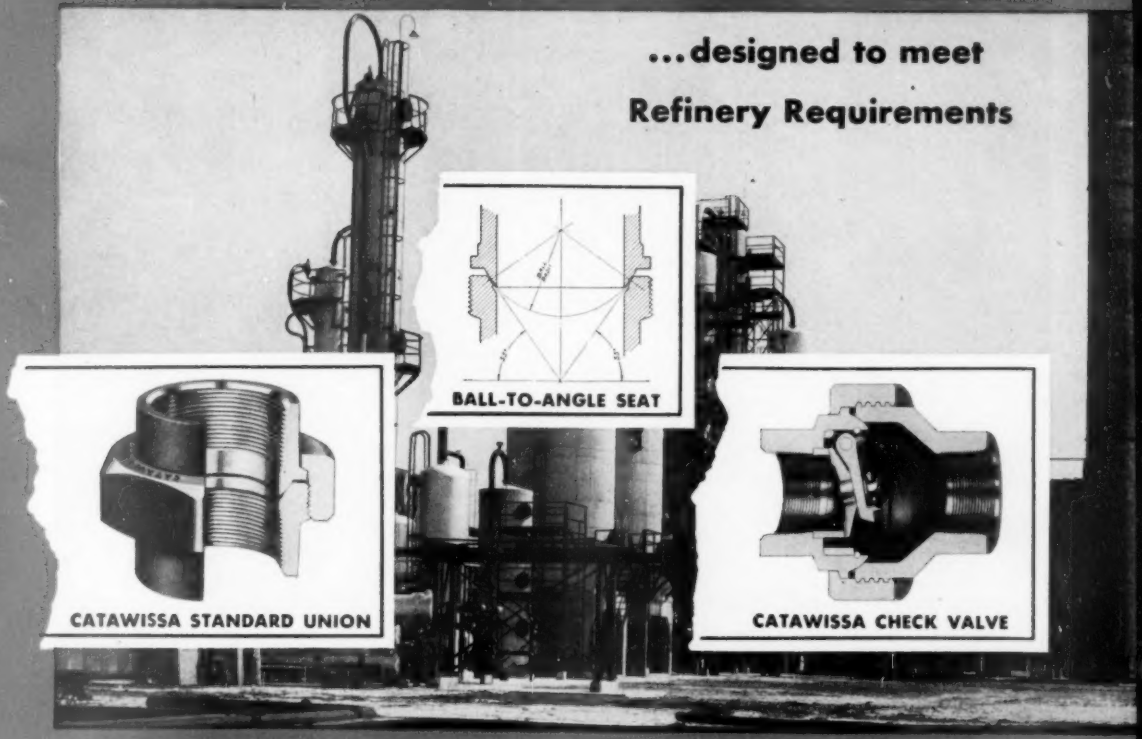
The Dump Bailer Service is becoming increasingly important to operators who have learned through experience the wide range of tasks it can perform efficiently for them. It has chalked up an impressive record in servicing wells during the past ten years . . . and its use is increasing daily.

Your nearby Halliburton representative can explain the advantages of letting trained specialists of the Dump Bailer Service perform swift, efficient, and satisfying remedial work for you on your next job. Or contact Halliburton Oil Well Cementing Company, Duncan, Oklahoma.

YEARS AHEAD IN REMEDIAL SERVICING!

HALLIBURTON

# Always specify "CATAWISSA" Unions and Check Valves




"OILWELL'S" strategically located refinery stock points carry complete lines of Catawissa forged-steel unions and check valves that meet the most severe refinery specifications.

### CHECK THESE FEATURES

HOT-FORGED . . . from solid, rectangular steel bars, Catawissa Unions are free from sand and blow holes. They will expand and contract with the pipe, assuring tight joints.

THREADS—Catawissa Unions and Valves are supplied with either full ACME threads or U. S. Standard V-threads in the union nuts and on the female end.

SEATS . . . in all Catawissa Unions are a 55° angle on the female end to a BALL on the male end, assuring a perfect seal even when the pipe is not perfectly aligned. Carefully hand-ground seats which require no packing are inspected and tested under water to assure holding qualities.

**Contact your nearest "Oilwell" representative—to assist you with your refinery problems.**

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USS "OILWELL"

UNITED STATES STEEL

# When Honest Work Comes High

Good, honest work like this comes mighty high when it's going into excessive piping repairs and replacements. And how do you control such high costs?

Thrifty buying with a careful eye on the quality of piping materials can help a lot. At today's maintenance rates, better quality was never a sounder investment. The more piping you have, the more you'll see how true this is.

Better quality equipment doesn't cost a penny more. Not when you know the savings it makes in longer life and fewer repairs. There's real economy in valves and fittings that do this. That's why Crane Quality makes Crane equipment the choice of the thrifty buyer.

Crane Co., *General Offices:* 836 S. Michigan Ave., Chicago 5, Ill. *Branches and Wholesalers Serving All Industrial Areas.*

# CRANE

**VALVES • FITTINGS • PIPE • PLUMBING • HEATING**

# Need Help on Difficult Threading Jobs?

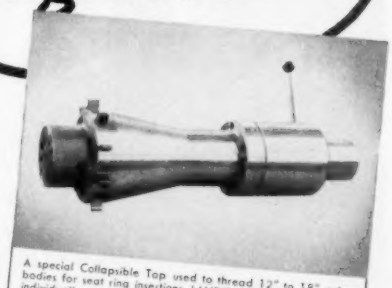
50th ANNIVERSARY

## LANDIS ENGINEERS DEVISE SPECIAL EQUIPMENT & METHODS FOR "HARD-TO-THREAD" WORKPIECES

Don't let the production of an unusual thread hinder an otherwise efficient manufacturing process. Hundreds of companies are today, with *LANDIS* equipment, profitably generating threads formerly considered impossible or too costly for practical operation.

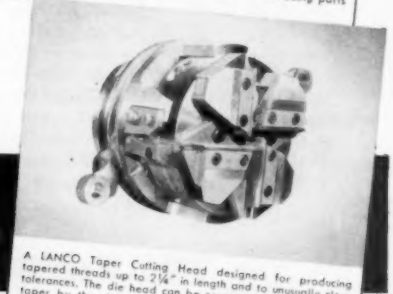
We offer to all manufacturers aid in solving problems in all phases of thread production. We will consult on the original design to insure that the proper thread to best serve a particular function is employed; we will advise as to the best standard equipment to produce a specific thread; we will develop special tooling for the production of an unusual or difficult thread; we will design special holding fixtures for threading workpieces that are difficult to chuck; or we will work out special methods to best fit multiple threading operations into the complete production process.

The illustrations show three examples of such Threading Problems solved by our Engineering Department. No matter what your Threading Problem—let our years of Thread Experience and Engineering Know-How work with you in its solution. Write or call *LANDIS* today.



A special Collapsible Tap used to thread 12" to 18" valve bodies for seat ring insertions. LANDIS Valve Seat Taps are individually engineered for their particular usage and are supplied to tap valve bodies from the 2" to the 24" size.

Double Diameter Chasers used to generate threads on reducing bushings and similar workpieces. These chasers cut threads on two different diameters simultaneously; thus, eliminating a second operation. Pitch and thread form for the two diameters must be identical and other limitations necessitate individually designed chasers for threading parts of different dimensions.



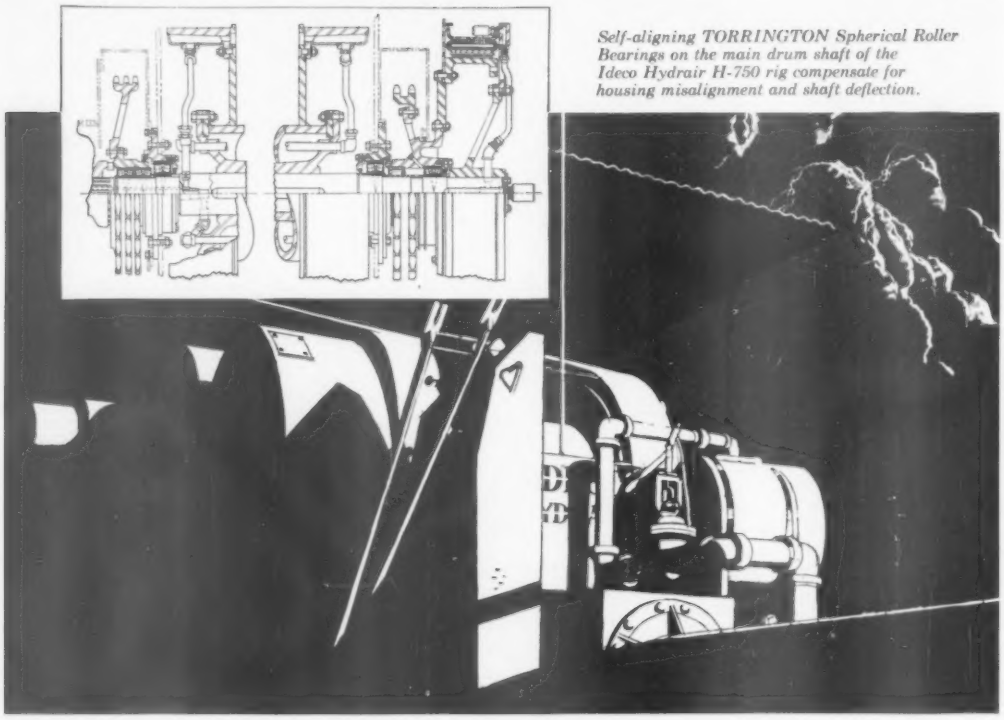
A LANCO Taper Cutting Head designed for producing tapered threads up to 2¼" in length and to unusually close tolerances. The die head can be converted to cut a reverse taper by the simple application of a reverse taper cam. Diameters from ½" to 2" and tapers ranging from zero to 2" per foot can be cut with this LANDIS Head.

# LANDIS *Machine* CO.

WAYNESBORO · PENNSYLVANIA · U. S. A.

THE WORLD'S LARGEST EXCLUSIVE MANUFACTURERS OF THREAD GENERATING EQUIPMENT

***Represented in the Domestic Oil Fields by:*** Colcord-Wright Machinery & Supply Co., St. Louis, Mo.; C. J. Harter Machinery, Houston, Texas; Frederic-Baker Co., New Orleans, La.; Moore Machinery Co., Los Angeles and San Francisco, Calif.; Hendrie & Bolthoff Mfg. & Supply Co., Denver, Colo.



*Self-aligning TORRINGTON Spherical Roller Bearings on the main drum shaft of the Ideco Hydrair H-750 rig compensate for housing misalignment and shaft deflection.*

# Drilling faster to greater depths!

TORRINGTON Bearings are helping drill to greater and greater depths—faster and more efficiently.

Example: the thousands of TORRINGTON Spherical Roller Bearings now in use on main drum shafts, cathead shafts and drawworks input shafts on many of the largest, most powerful drilling rigs (typical cross section above).

TORRINGTON Spherical Roller Bearings are self-aligning. They compensate for housing misalignment and shaft deflection. They cut installation time and reduce costly shutdowns due to bearing replacement.

TORRINGTON Spherical Roller Bearings have cast-bronze *land-riding* cages. They roll smoothly at all speeds, stand up longer under exacting drilling schedules.

And like *all* Torrington Bearings, TORRINGTON Spherical Roller Bearings are *precision-ground*. Their conformity factors and surface finishes are second to none.

Get these installation and operating advantages in your own equipment. Specify TORRINGTON Spherical Roller Bearings.

THE TORRINGTON COMPANY
South Bend 21, Ind. • Torrington, Conn.

**TORRINGTON SPHERICAL ROLLER BEARINGS**

Spherical Roller • Needle • Tapered Roller • Straight Roller • Ball • Needle Rollers

# LONG HAUL... OR SHORT HAUL...

**THERE'S A SANTOLUBE OIL ADDITIVE TO IMPROVE EVERY KIND OF ENGINE PERFORMANCE**

Truck engines that pull heavy loads and run for long periods of time at high temperature . . .

Passenger car engines that pull light loads and run for short periods at low temperature . . .

For both these extremes of operation—as well as the full range in between—Monsanto makes a complete line of Santolube oil additives. They can be added to numerous base stocks and be custom-fitted to the kind of oil you produce. More important, these additives will help your oil fight corrosion, inhibit oxidation, keep engines clean, reduce engine wear.

Here are a few of the kinds of additives made by Monsanto:

- Pour point depressants
- Motor oil inhibitors
- Viscosity index improver
- Gear lubricant additives
- Motor oil detergents
- Corrosion inhibitor for distillate fuels
- Sludge inhibitor for domestic oil fuels
- Cutting oil additive
- Inhibitor detergent combinations for premium and heavy-duty service

**Write for more information** to MONSANTO CHEMICAL COMPANY, Organic Chemicals Division, 800 North Twelfth Blvd., St. Louis 1, Missouri.

*Santolube: Reg. U. S. Pat. Off.*

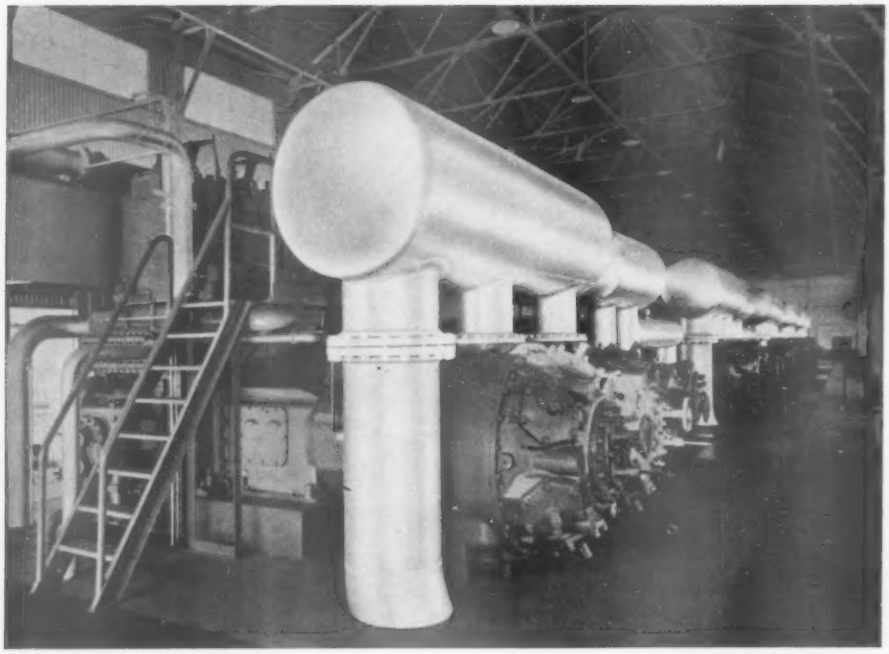
**SANTOLUBE**

MONSANTO
CHEMICALS—PLASTICS

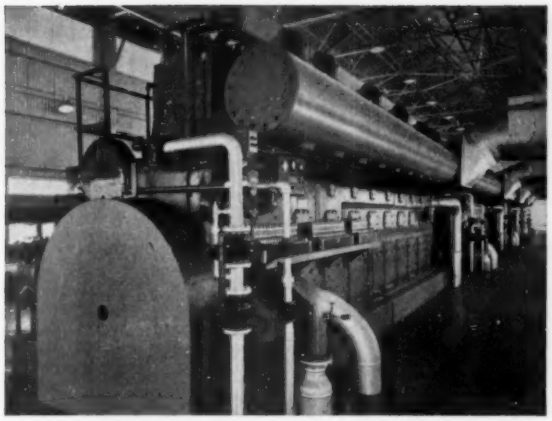
**SERVING INDUSTRY...WHICH SERVES MANKIND**

## Ringwood gasoline plant now a reality after 7-year struggle with engineering obstacles

**Clark Compressors**



© 1952, Clark Bros. Co., Division of Dresser Operations, Inc.



# help solve a major problem

Since the development of Ringwood producing field (near Enid, Oklahoma) was begun in 1945, several oil and gas corporations had considered constructing a natural gasoline plant to process this field's gas. It was not until early 1951 that the joint effort of Warren Petroleum Corporation and Oklahoma Natural Gas Company finally resulted in a plan which would justify the present operating facilities.

Design engineers first had to overcome three major obstacles to assure economically sound operations — (1) Shortage of water. (2) Relatively lean gas. (3) Widespread gathering area.

One of the principal problems was compressor selection. Conditions demanded unusually high efficiency and low operating costs. The solution: Five Clark 2500 bhp HLA-10 Gas-Engine-Driven Compressors, the largest available in the world today. The reasons:

- Their high thermal efficiency assured maximum conversion of fuel gas heat value to power, with a minimum rejected to the cooling water.
- Their high compressor cylinder efficiency was essential because of the volume of lean gas to be handled.
- Their greater power packed into fewer units meant less operating personnel.

Now on stream for several months, this unique gasoline plant has already proved the feasibility of operating under these extremely adverse conditions.

For complete information on the Clark Compressors that contributed to its success, write for Bulletin 113.

**CLARK BROS. CO. • OLEAN, N. Y.**

*Division of Dresser Operations, Inc.*

OFFICES IN PRINCIPAL CITIES THROUGHOUT THE WORLD

***PRECISION BY THE TON***

**CLARK compressors**

Three Cleveland 10RT speed reducers (with 3" centers) on a six cylinder gang pump installed in a California oil plant. Two of the worm gear units drive pumps at 88 strokes per minute, the third at 70 strokes per minute. Photo by courtesy of Milton Roy Company.

# Small CLEVELANDS provide wide range of stroking speeds for Milton Roy pumps

THIS Milton Roy controlled volume pump meters 3 liquids in exact ratio—fatty acid, sulphuric acid, and glycerin, delivered at differing speeds.

To provide the variation of stroking speeds necessary and to insure accurate control of proportioning and volume, the pump builder uses three small Cleveland worm gear reducers with a variable speed motor.

Cleveland worm gear units take up a minimum of space. They transmit power with a smooth, uniform torque flow. Case-hardened steel worms mesh with nickel-bronze gears for long, hard, dependable service without appreciable wear. Throughout the chemical and allied industries, you'll find Clevelands—big and small—driving pumps, agitators, mixers—in fact, every kind of equipment for which a right-angle drive is needed.

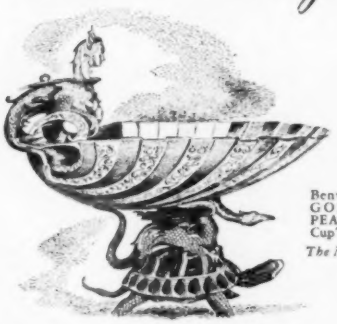
If you have a power transmission problem, you can get help by writing for Catalog 400. The Cleveland Worm & Gear Company, 3286 East 80th St., Cleveland 4, Ohio.

*Affiliate: The Farval Corporation, Centralized Systems of Lubrication. In Canada: Peacock Brothers Limited.*

**CLEVELAND**
**Worm Gear**
*Speed Reducers*

TO THOSE WHO PREFER

*individuality*



Benvenuto Cellini. CUP OF GOLD, ENAMEL, and PEARLS (The "Rospigliosi Cup"). Italian 16th century.
*The Metropolitan Museum of Art*

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*Distinguished Hotels*

A good hotel, like a fine *objet d'art*, is appealing for its individual characteristics and personality. Each of these hotels interprets good living with a distinctive flair, making your visit a unique and exciting experience. No note of sameness mars the adventure of your stay, for each is individually owned and managed.

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Ioco Refinery, near Vancouver, British Columbia

# IMPERIAL OIL LIMITED

## ...New Link in Chain of Canadian Oil Developments

An important refinery project will be completed in British Columbia this fall, in time to process early deliveries of Alberta crude from the Trans Mountain Oil Pipe Line.

It is the Ioco plant of Imperial Oil Limited, now under construction by Canadian Bechtel Limited. The design provides for a flexible operation, producing a wide range of petroleum products.

Ioco is another all-Bechtel job—engineering, procurement and construction—services that are available promptly for projects in any part of the world.

**BECHTEL CORPORATION**

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**Associate Company: CANADIAN BECHTEL LIMITED**

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# Facts prove the economy of RUST-OLEUM®

## Apply Directly Over Sound Rusted Surfaces

Just scrape and wirebrush to remove rust scale and loose particles — then brush Rust-Oleum 769 Damp-Proof Red Primer *directly over sound rusted surface.*

## Lasts Longer Applied Directly Over Rust

Sandblasting, chemical pre-cleaning and other costly preparation methods are not usually required. Rust-Oleum penetrates the rust to bare metal, incorporating the rust particles into the coating.

## Many Colors, Including Aluminum, and White

Rust-Oleum finish coatings incorporate the same basic rust-inhibiting vehicle as Rust-Oleum 769 Damp-Proof Red Primer. They provide *double protection* and enable you to *beautify as you protect.*

## Practical Answer to Your Rust-Producing Conditions

Rust-Oleum resists rain, snow, heat, fumes, sun, salt water, and chemicals. So easy to use by brush, dip, or spray that one man often does the work of two.

## Proved Throughout Industry for Over 25 Years

Indoors and out, Rust-Oleum has *proved* its capacity to stop rust! Rust-Oleum can do the same for your tanks, metal sash, stacks, girders, roofs, buildings, machinery, pipes, etc.

## An Exclusive Formula

Rust-Oleum is *distinctive* as your fingerprint. It incorporates a specially-processed fish oil vehicle that *dries,* is odor-free, and is formulated in *many colors.* Specify Rust-Oleum — accept no substitutes.

*There Is Only One Rust-Oleum*

# RUST-OLEUM STOPS RUST!

**ATTACH TO YOUR LETTERHEAD — MAIL TODAY!**

RUST-OLEUM CORPORATION
**2543 Oakton Street, Evanston, Illinois**

- ☐ Have a Qualified Representative Call
- ☐ Free Survey
- ☐ Complete Literature
- ☐ Nearest Rust-Oleum Industrial Distributor

# CONTROL

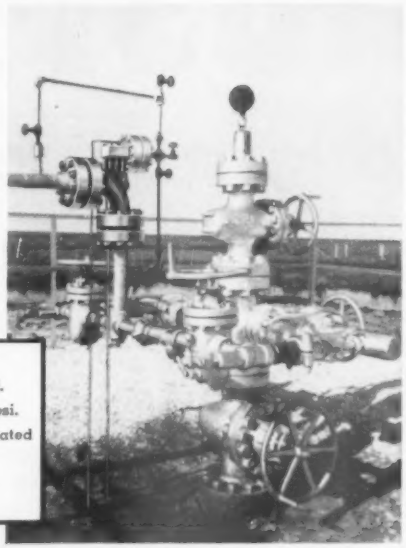
GROVE REGULATORS AND VALVES provide accurate, dependable pressure and flow control for air, gas, oil, water and other fluids. The proved principles embodied in Grove products are the results of years of intensive research and extensive field experience. Today these products are widely used in every branch of industry. Let Grove help with your control problems. Technical information gladly supplied.

## Grove Well Head Protection Systems assure positive automatic shut-off

Be ready for any well head emergency. Without fail, Grove Model 390 Protection Systems instantly stop the flow — dead tight . . . safeguarding equipment, preventing waste. They operate as often as required — many times a day, or once in a lifetime. Overpressure or underpressure settings are easily made in the field. Resetting can be manual or automatic.

Model 390 main and pilot valves utilize the patented Grove dome-loaded diaphragm-operated principle. Pressure range is universal. Loading is quick and accurate. Elimination of springs, pistons and stuffing boxes assures a tight seal with no chance of corrosion or sticking.

Grove automatic Well Head Protection Systems offer the safest, surest emergency shut-off control available. Contact your nearest Grove representative for details.



**SPECIFICATIONS**

- Controls well pressures up to 6000 psi.
- Maximum overpressure setting — 5000 psi.
- Maximum underpressure setting — 4000 psi.
- Overpressure, underpressure or pilot-operated combination units.
- Angle or in-line design.
- Screwed or flanged connections.

11-2

**VALVES AND REGULATORS**

**GROVE REGULATOR COMPANY**

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# 40 YEARS

. . . OF PROGRESS IN FABRICATION!

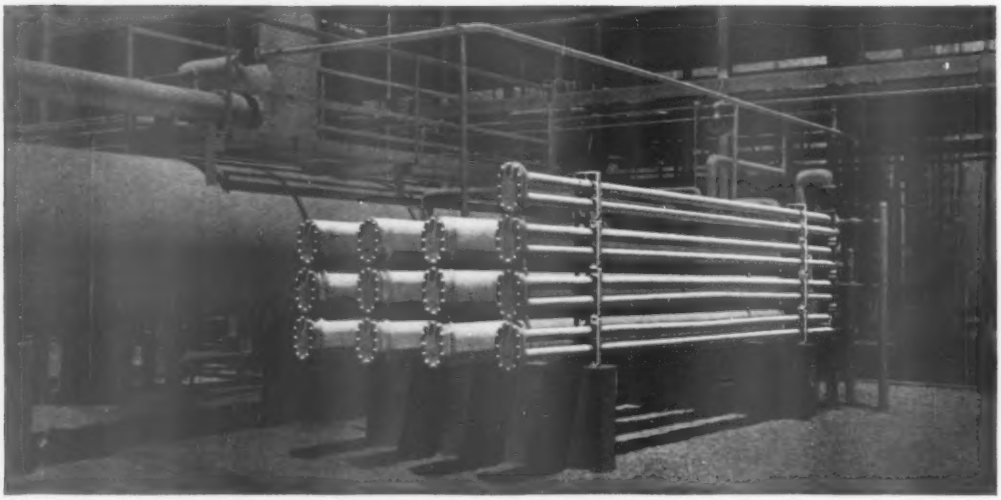
STEEL PLATE FABRICATORS AND ERECTORS SINCE 1913

Wyatt's

HOUSTON-DALLAS-NEW YORK-TULSA

# *Assure Flexibility*

## in your plant with



## BROWN FINTUBE *Sectional* HEAT EXCHANGERS

● Production schedules — and processing techniques change. Consequently, you can never know positively, what your fluid heating and cooling needs will be next year — or even next week. Because Brown Fintube Heat Exchangers consist of *standard sections* connected in proper series-parallel arrangement, they can be rearranged easily and quickly to meet changing conditions.

You simply add, or remove, a few sections, or change the series-parallel manifolding. The plant can be operating efficiently, on almost any new duty, on short notice,— and with a minimum investment in new equipment. "Bundle" type exchangers are not flexible. For them a change involves the delay and expense of designing — and waiting — for a whole new unit.

Flexibility is only one of Brown Fintube's many advantages. You'll find full details in our Bulletin No. 512. Send for a copy. It will give you ideas.

BROWN FINTUBE CO.
*Elyria, Ohio*

● Integral One-piece Fintubes; Sectional Heat Exchangers and Coolers; Vertical Heaters for Bulk Storage Tanks; Tank Suction Heaters; Pressure and Suction Line Heaters; Process Tank Heaters; Fired Indirect Heaters and Special Types of Fintube Heaters and Coolers.

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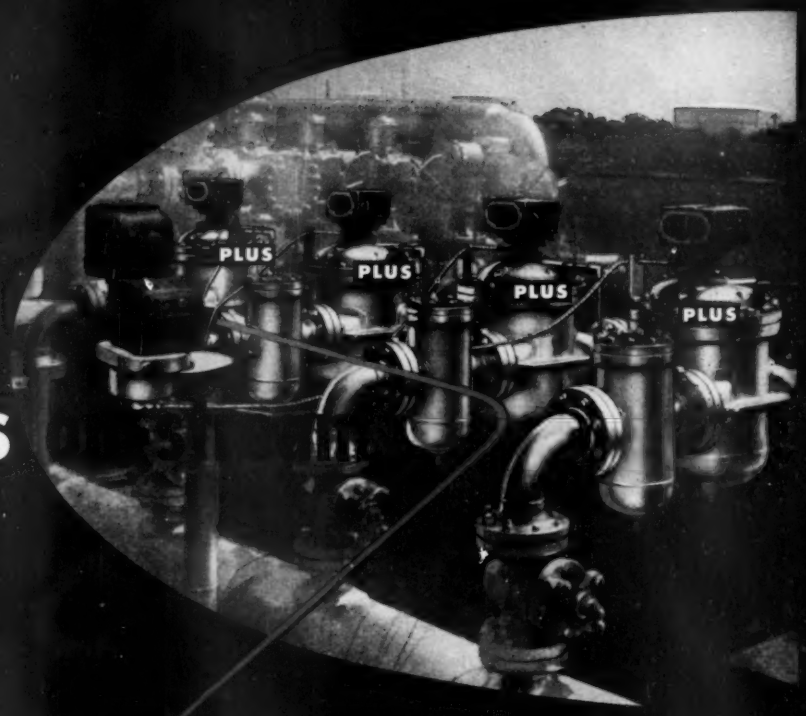
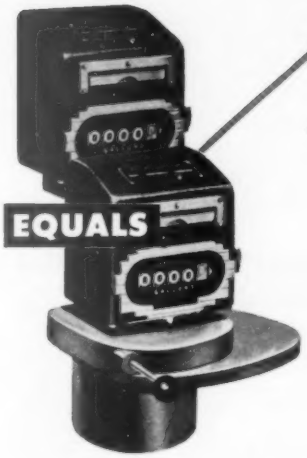
MEMPHIS • BIRMINGHAM • NEW ORLEANS • SHREVEPORT • TULSA • HOUSTON • DALLAS • LOS ANGELES • SAN FRANCISCO • and ST. THOMAS, ONT.

# always




*DUAL TICKET PRINTER MULTI-METER TOTALIZER UNIT equipped with counter shifter. This permits alternate printing of a single ticket for each product tender without stopping the flow. Installation (above) includes Cable Drive Take-offs from each of four Model W-50 SMITHway High Pressure Meters equipped with Automatic Temperature Compensation.*

NEWEST THING in high capacity measurement is the use of SMITHway Meters in multiples. A bank of four meters, for example, equipped with a multimeter totalizer permits flow rates as high as 4,200 BBLS./HR. In effect, this system provides single recording plus the flexibility obtainable only from multiple meters.

When flow varies, meters may be cut out to suit line conditions, thus assuring maximum accuracy at all flow rates. When meters require service, you remain on-stream. Only a minimum of down-time is required to service one of these units and during this time the other meters carry on with no loss in meter or line efficiency. Write today for Bulletin 126-A.

79th ANNIVERSARY 1874 - 1953

**A.O.Smith**

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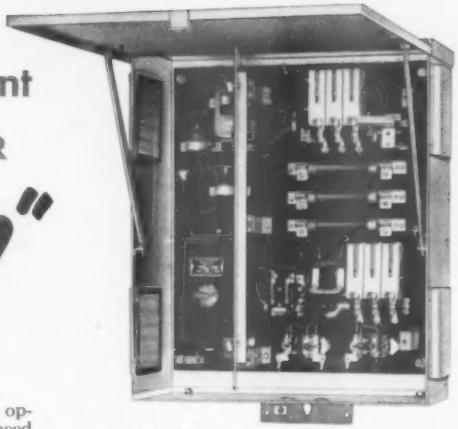
# We give you what you want in genuine CUTLER-HAMMER "Oil Country" well pumping control



C-H 9589 oil well pumping controller with 3 coil overload and undervoltage relay.

Cutler-Hammer went to the oil country to find out what oil operators, practical production men, maintenance crews really need and want in their oil well pumping control.

And Cutler-Hammer Oil Country Control *proves out*. The practical way in which heat is shielded out and fresh clean air pours in around the working mechanism proves out. You never see C-H control with the door propped open to keep it working.

The extraordinary care to keep out dirt, large particles of dust and bugs proves out. Louvres, bronze-screening and baffle plates do their work. And the famous C-H Vertical dust safe contacts shed dirt and dust to keep clean, sure contacts. Timer is neoprene-gasketed and dust proof. And the excess torque time clock keeps going if inadvertently dust gets in.

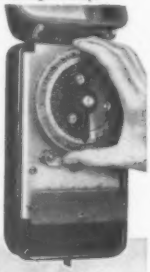
Undervoltage relay if you want manual restarting. Automatic time delay if you want automatic staggered starting of groups of motors.

Full three phase protection with 3 coil overload relays if you want to avoid motor burnouts which can result from single phasing.

Pumping sequence changes are made in 15 minute increments. You just pull small, accessible tabs. Day omission feature is also available on the time programming switch when your scheduling calls for skip-a-day pumping.

Unit type lightning arresters that tell at a glance if they've blown and eliminate the need to clean up or rebuild the starters.

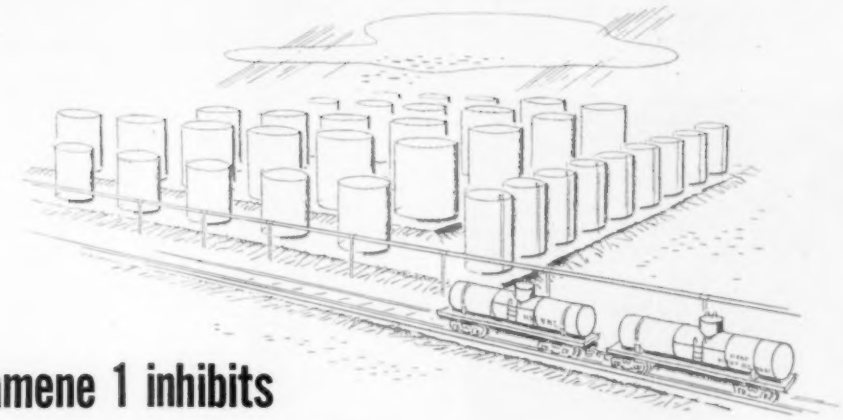
There are so many wanted features on these controllers, there is not room enough to tell them all. Ask for further information. Or better still, try out a C-H starter and compare it with the performance of any other make you have ever had. CUTLER-HAMMER, Inc., 1453 St. Paul Avenue, Milwaukee 1, Wisconsin. *Associate:* Canadian Cutler-Hammer, Ltd., Toronto.



Program Time Switch automatically schedules pumping, set up easily by pull tabs—one for each 15 minute interval. Day omission feature also available, for non-operation any selected days of week.

CUTLER-HAMMER
MOTOR CONTROL
C-H

MEMBER AMERICAN PETROLEUM INSTITUTE



# Tenamene 1 inhibits gum formation for as little as 2½¢ per barrel of gasoline

Tests under tough varying plant conditions show that Tenamene 1 is the most effective low-cost gum inhibitor known to the petroleum industry.

Refiners find that a little Tenamene goes a long way. In a typical case, only 5 pounds of Tenamene 1 are needed to treat 1000 barrels of gasoline—that's effective protection against gum for approximately 2½¢ per barrel!

If you're interested in general information about gum inhibiting as well as specific data about the Tenamenes, send for the booklets listed in the coupon. Our Petroleum Chemicals Laboratory will be glad to make tests and recommendations on any of your gum inhibiting problems.

**SALES OFFICES: Eastman Chemical Products, Inc.,** Kingsport, Tenn.; New York—260 Madison Ave.; Framingham, Mass.—7 Hollis St.; Cleveland—Terminal Tower Bldg.; Chicago—360 N. Michigan Ave.; St. Louis—Continental Bldg.; Houston—412 Main St. **West Coast: Wilson Meyer Co.,** San Francisco—333 Montgomery St.; Los Angeles—4800 District Blvd.; Portland—520 S. W. Sixth Ave.; Seattle—821 Second Ave.

**Tenamene** EASTMAN GASOLINE ADDITIVES

**Eastman**
CHEMICAL PRODUCTS, INC.
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**Eastman Chemical Products, Inc.,**
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Gentlemen: Send me copies of your booklets: "Inhibiting Motor Fuels with the Tenamenes" and "Tenamene 2 Inhibitor Sweetening."

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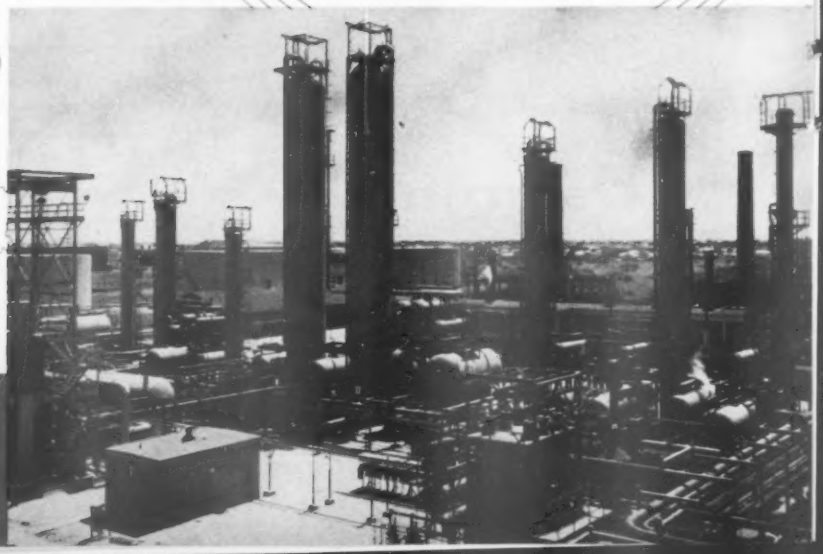
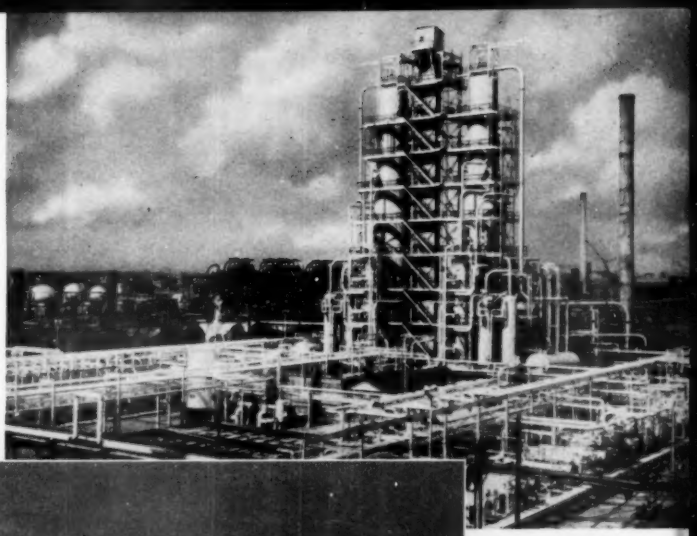
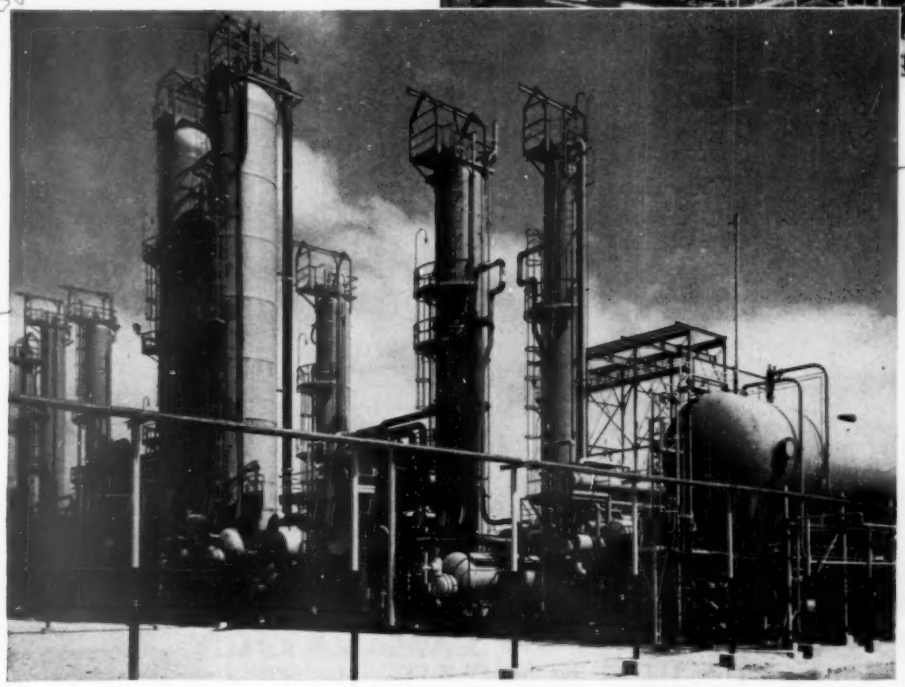
Sales representative for **TENNESSEE EASTMAN COMPANY,** division of **EASTMAN KODAK COMPANY**

IN almost every country in the world and every state in the union where you find petroleum refining you'll find McKee engineering. Every year sees an increase in the number and size of projects designed and constructed by McKee . . . new names added to the list of countries in which McKee has executed contracts.

The reason for this steady growth lies in the excellence of McKee engineering, the soundness of McKee construction and the close coordination of these functions with expeditious purchasing services. That's why oil men from all over the world come to McKee again and again for *engineering that means assured results.*





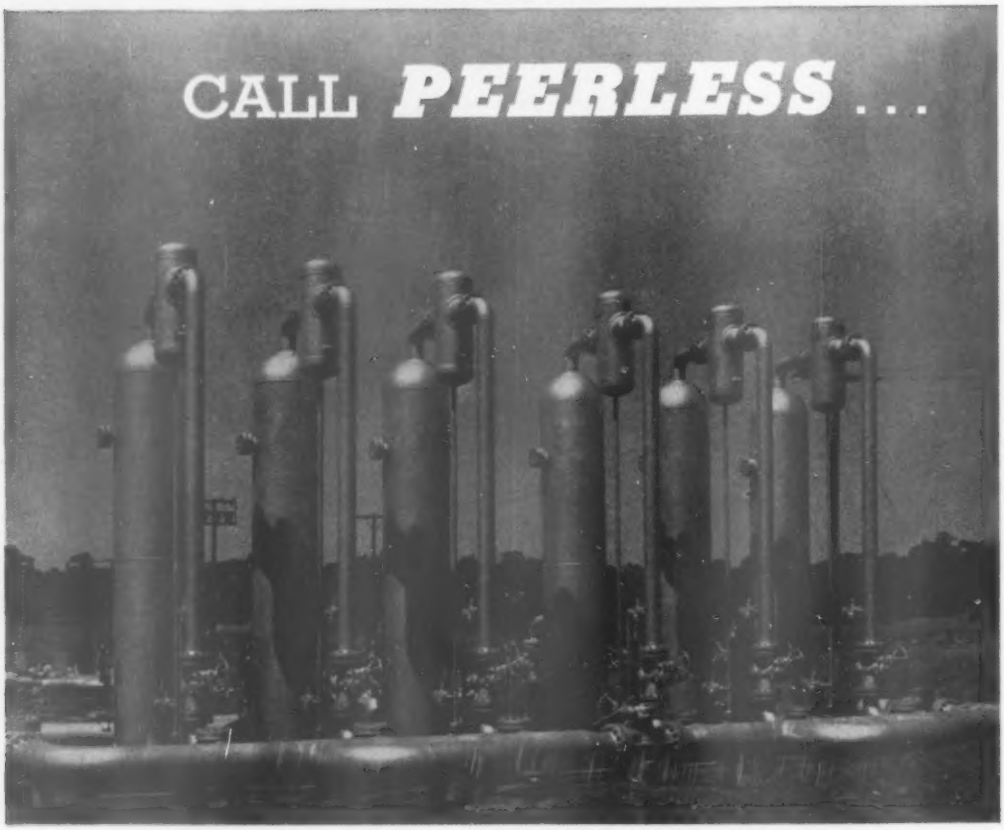


**ENGINEERING, PURCHASING AND CONSTRUCTION FOR THE PETROLEUM REFINING AND IRON AND STEEL INDUSTRIES**

**Arthur G. McKee & Company • Established 1905**

*Headquarters:* McKee Building, 2300 Chester Avenue, Cleveland 1, Ohio.
*Offices:* New York • Tulsa, Oklahoma • Union, New Jersey • Washington, D. C.
*British representatives of Metals Division:* Head, Wrightson & Company, Ltd.
*Canada:* **Arthur G. McKee & Company of Canada, Ltd., 350 Bay St., Toronto 1, Ont.**

# Have ENTRAINMENT PROBLEMS..?




## . . . SPECIALISTS in the SEPARATION LIQUIDS and GASES!

**Graphically illustrated is the use of the Peerless line separator to eliminate liquid entrainment losses.**

**This installation is typical of the many successful applications of Peerless equipment.**

*Consult Peerless for help in solving your entrainment problems.*

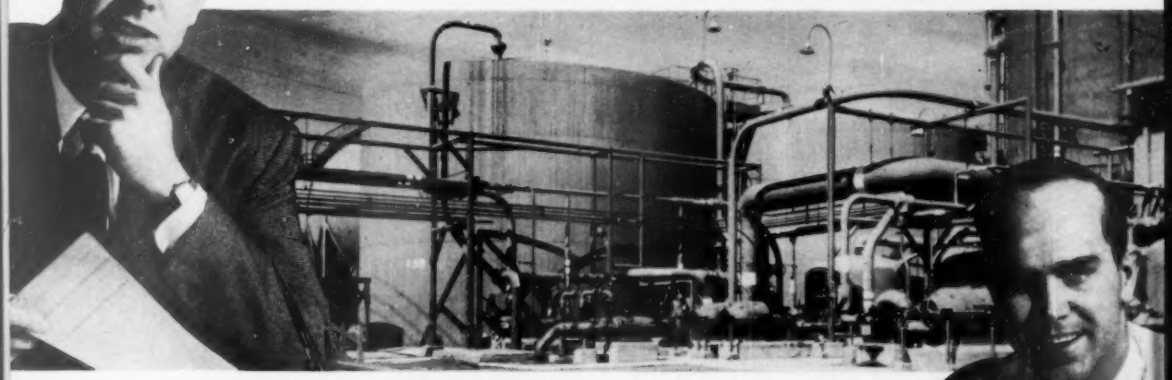
PEERLESS MFG. CO.

**PEERLESS MANUFACTURING CO.**

P O BOX 7193 ★ DALLAS, TEXAS ★ DIxon 8431

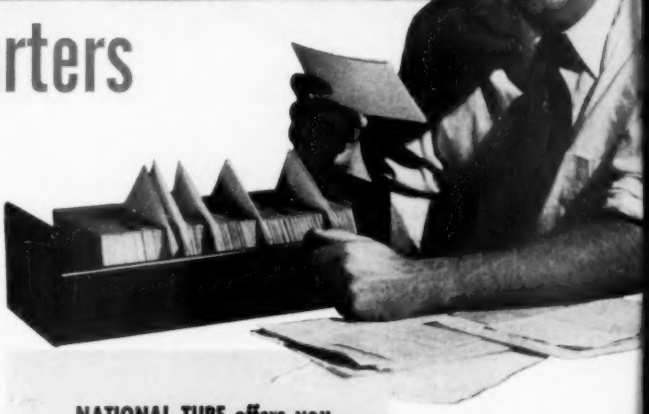
REPRESENTATIVES IN ALL PRINCIPAL CITIES

# When you're up against a tubing problem . . .



# Tubing Headquarters

## can help you solve it!



WHEN the question of tubing comes up for a new installation or for replacement, don't cross your fingers and "take a shot in the dark" hoping that your choice will prove the answer to your needs. Play safe! Come to Tubing Headquarters. Tell National Tube what conditions are at your plant. The chances are that we have already helped other refineries handle similar situations . . . *and successfully.* In fact our files are filled with case histories, the results of laboratory tests, and actual field observations involving National Seamless Steel Pipe and Tubing under practically every condition of temperature, pressure, corrosion and exposure.

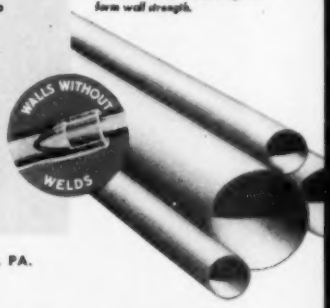
Out of this research and study have come important developments in tubing steel which enable National Tube to offer you seamless steel tubing, condenser tubes, heat exchanger tubes, and refinery piping in *24 different analyses.* Each of these 24 different analyses has been performance-proved to meet the specific conditions of corrosion and oxidation for which it is recommended.

We invite you to bring your problems to National Tube. Our tubing specialists will work closely with your own engineers to see that you get *just the right* tubes and piping for your particular requirements.

**NATIONAL TUBE offers you**
**Seamless Steel Still Tubes**
**Condenser Tubes**
**Heat Exchanger Tubes**
**Refinery Piping**
**in 24 DIFFERENT ANALYSES**

| | |
|---|---|
| Carbon | 7 Cr, ½ Mo |
| Carbon, ½ Mo | 8 Cr, ½ Mo |
| ½ Cr, ½ Mo | 8 Cr, 1 Mo |
| 1 Cr, ½ Mo | 9 Cr, 1 Mo |
| 1¼ Cr, ½ Mo | 12 Cr, Al |
| 2 Cr, ½ Mo | 17 Cr |
| 2¼ Cr, 1 Mo | 27 Cr |
| 2½ Cr, ½ Mo, ¾ Si | 18-8 |
| 3 Cr, 1 Mo | 18-8 Ti |
| 5 Cr, ½ Mo | 18-8 Cb |
| 5 Cr, ½ Mo, 1½ Si | 18-8 Mo |
| 5 Cr, ½ Mo, Ti | 25-20 |

*All National Seamless Tubes are pierced from a solid billet of high-quality steel. This is the one manufacturing method that removes all doubt concerning uniform wall strength.*




NATIONAL TUBE DIVISION, UNITED STATES STEEL CORPORATION, PITTSBURGH, PA.
*(Tubing Specialties)*
COLUMBIA-GENEVA STEEL DIVISION, SAN FRANCISCO, PACIFIC COAST DISTRIBUTORS
UNITED STATES STEEL EXPORT COMPANY, NEW YORK

USS

## U·S·S NATIONAL SEAMLESS PIPE AND TUBES

UNITED STATES STEEL

## Graphic Instrumentation . . . *from idea to installation*

SIMPLER supervision, greater operating efficiency . . . improved coordination . . . these are some of the contributions that graphic instrumentation is making in the process industries. Recognizing the ever increasing importance of graphic techniques, Honeywell offers complete engineering service . . . covering instrumentation, panel design, and construction.

### Instruments

*Tel-O-Set* miniature indicators and recorders are supplied for temperature, pressure, flow and liquid level. They take a front-of-panel space only 5 inches square . . . fit readily into process diagrams. They meet the most critical demands for accuracy, simplicity, and utility.

Behind the panel are compact *Tel-O-Set* Controllers. They provide a choice of control actions.

Console desks, with integrally-mounted *ElectroniK* Precision Indicators, give operators a convenient means of monitoring a large number of critical temperatures.

For remote transmission, Honeywell has a full line of temperature, pressure, flow and level transmitters and receivers of both pneumatic and electric types . . . working with a broad selection of sensing elements.

### Panel Design

Every panel is custom-designed for its intended job by Honeywell's staff of panel engineers. After initial consultations, they develop a layout that fits all instruments, signals, remote control stations and other equipment in a coordinated design. All elements are located for greatest convenience and ease of manipulation. The overall appearance is made attractive and simple to follow, to aid in reducing operator fatigue. Final working drawings are prepared following consultation with the customer . . . then actual fabrication begins.

### Panel Construction

In Honeywell's shop devoted exclusively to panel production, skilled workmen do a complete assembly job. Every instrument, controller and accessory is mounted in place. All back-of-panel wiring and piping is completed, so the board is ready to connect to plant equipment. Before shipment, the entire panel goes through rigorous tests to assure trouble-free installation and start-up when the panel reaches its destination.

# Squeezing out with the

*Instruments*

*Design*

*Construction*

**MORE THAN** *50 Tel-O-Set Indicators and Recorders are mounted on this Honeywell graphic panel. The section shown here includes temperature, pressure, flow and liquid level controllers for a coking unit.*

# higher yields — help of *centralized control*

DESIGNED to upgrade reduced crude, the Lummus coking unit at a big refinery gets the last useful drop out of feed stock. Centralized control, by means of a Honeywell graphic panel, keeps all critical process variables in line...simplifies supervision of the entire process.

Accurate control pays dividends here. In fractionation, it helps to obtain maximum throughput and quality of the desired cuts, and to get proper composition of the coking furnace feed. In the coking furnace, precise control prevents formation of coke in the furnace tubes, assuring efficient operation.

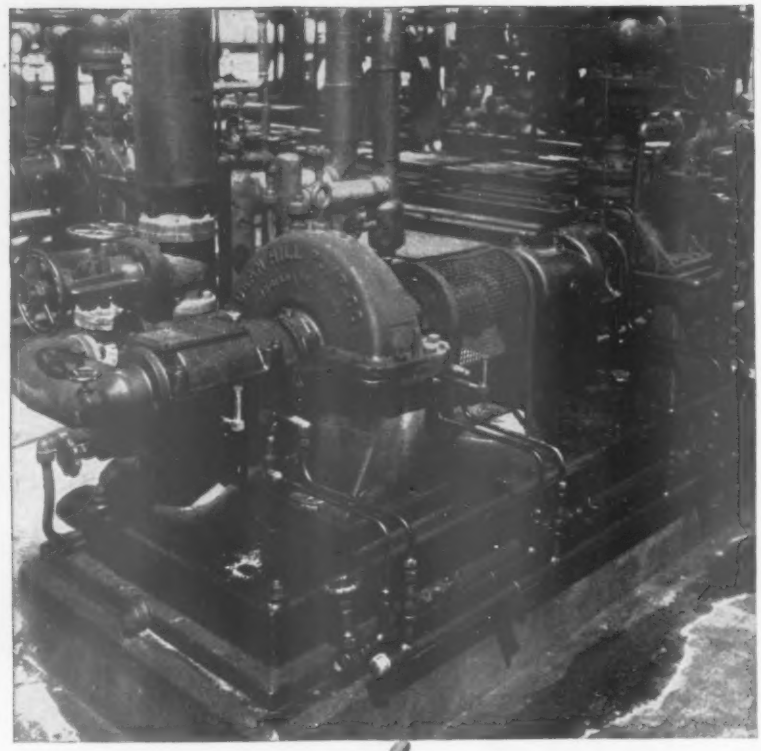
*Tel-O-Set* recorders, installed in the process diagram, give operators precise, readily readable facts on each variable. And behind the panel, their companion *Tel-O-Set* controllers automatically regulate critical variables throughout the unit. The entire panel functions as one giant instrument... functional but attractive in appearance... efficient and precise in operation.

Our local engineering representative will be glad to discuss how panels by Honeywell can help you get the most from your process. Call him today... he is as near as your phone.

MINNEAPOLIS-HONEYWELL REGULATOR CO., *Industrial Division*, 4488 Wayne Ave., Philadelphia 44, Penna.

● **REFERENCE DATA:** Write for Composite Catalog No. 5000 for a condensed description of the complete Honeywell line.

MINNEAPOLIS
**Honeywell**
BROWN INSTRUMENTS
*First in Controls*



## DEAN HILL STEAM TURBINES

are single stage, double impact type for low steam consumption. Specifically designed for operation at medium steam pressures and temperatures, DH Turbines have all the advantages available under these conditions, including excellent water rates. Get the full details and complete specifications. Write today.

# POWERFUL "PENNY PINCHER"

Power a-plenty at a penny-pinching cost! That's how DEAN HILL STEAM TURBINES operate. Their super rugged construction, their service-engineered design, their low maintenance, their remarkable power-producing ability all add up to far more service for your turbine dollar. If it's low cost power you want . . . you want DEAN HILL STEAM TURBINES.

## DEAN DH HILL PUMP COMPANY

*Pump and Turbine Engineers Since 1895*

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# An unbeatable team for temperature measurement

## DYNALOG RECORDERS and DYNATHERM BULBS

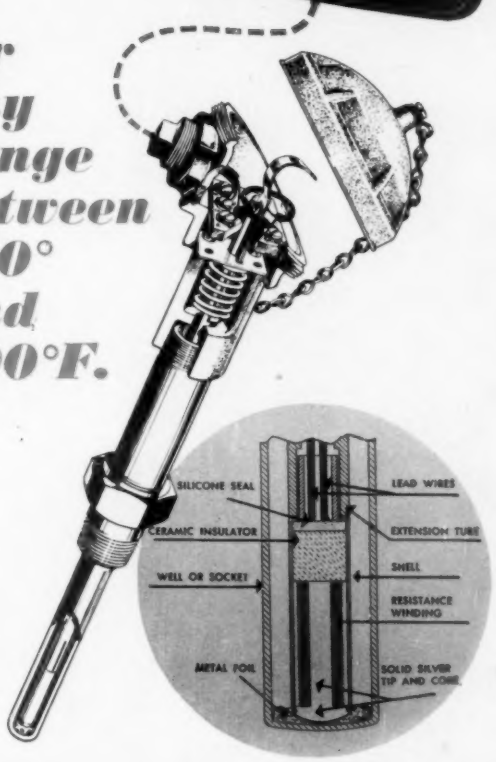
You can't beat this Foxboro Dynalog-Dynatherm combination for insuring better temperature measurement on any job between–100° and+600°F. It gives you every advantage of speed, accuracy, long leads, simple installation, economy, and freedom from maintenance. This is why:

**The Dynalog Electronic Recorder** has an exclusive variable-capacitor measuring system which eliminates slidewires, gears, cables, high speed balancing motors . . . no dead space, no batteries to standardize, no motors to service. Standard full-scale pen speed only 3 seconds. Sustained accuracy ¼ of 1% guaranteed. Available for spans as narrow as 5°F. with full-accuracy calibration.

**The Dynatherm Resistance Bulb** has unique features including metal-to-metal end-contact which, when installed in a well or socket, gives a speed of response unsurpassed by any other similarly protected temperature-sensitive element. Exceptionally rugged and permanent in calibration.

These are only a few of the important advantages of this better temperature measuring system . . . available also for control of temperatures, or with Multi-Record Dynalog Recorder for up-to-6 records on one chart. Write for illustrated bulletins, The Foxboro Company, 603 Neponset Ave., Foxboro, Mass., U.S.A.

*for any range between -100° and +600°F.*

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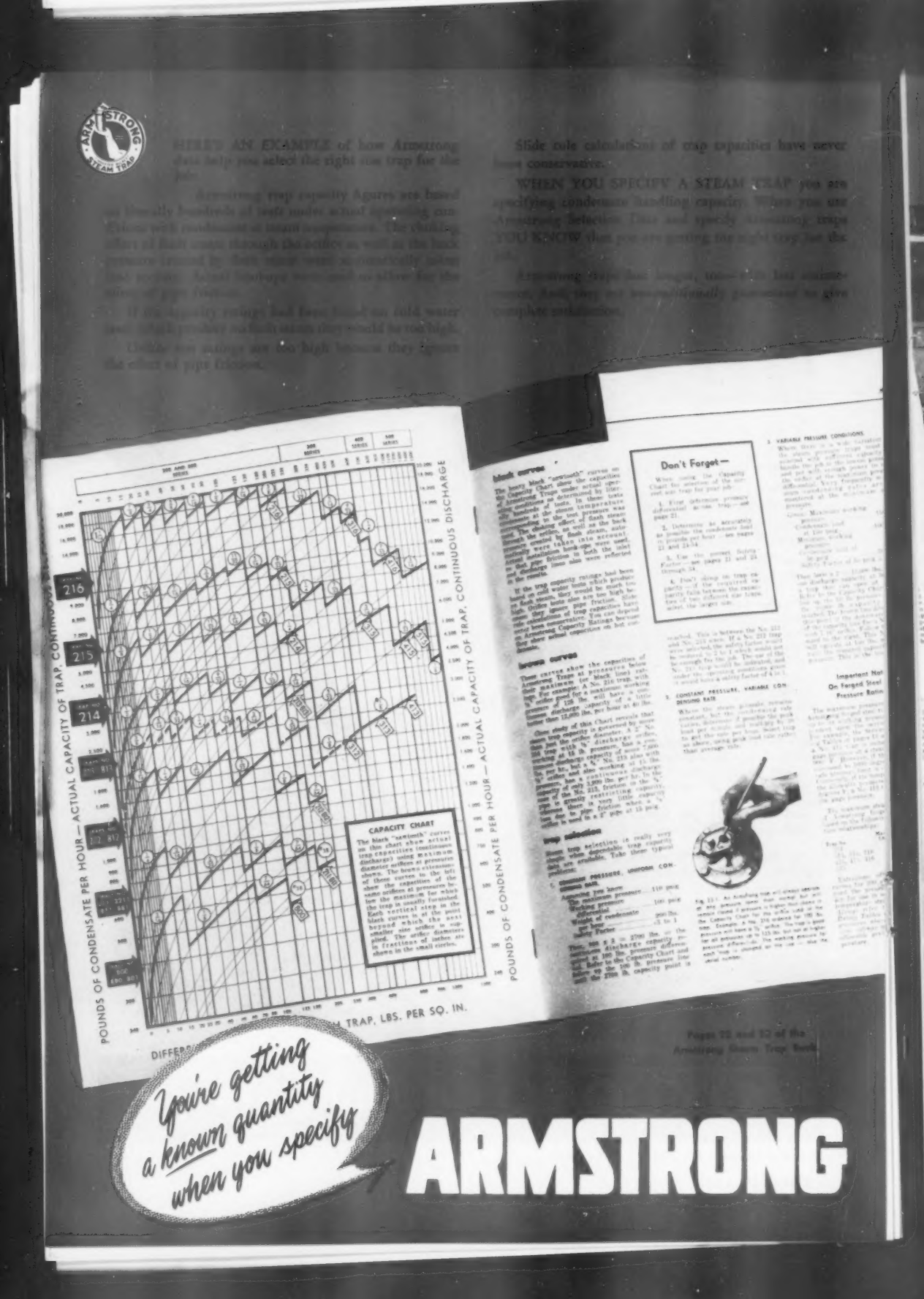
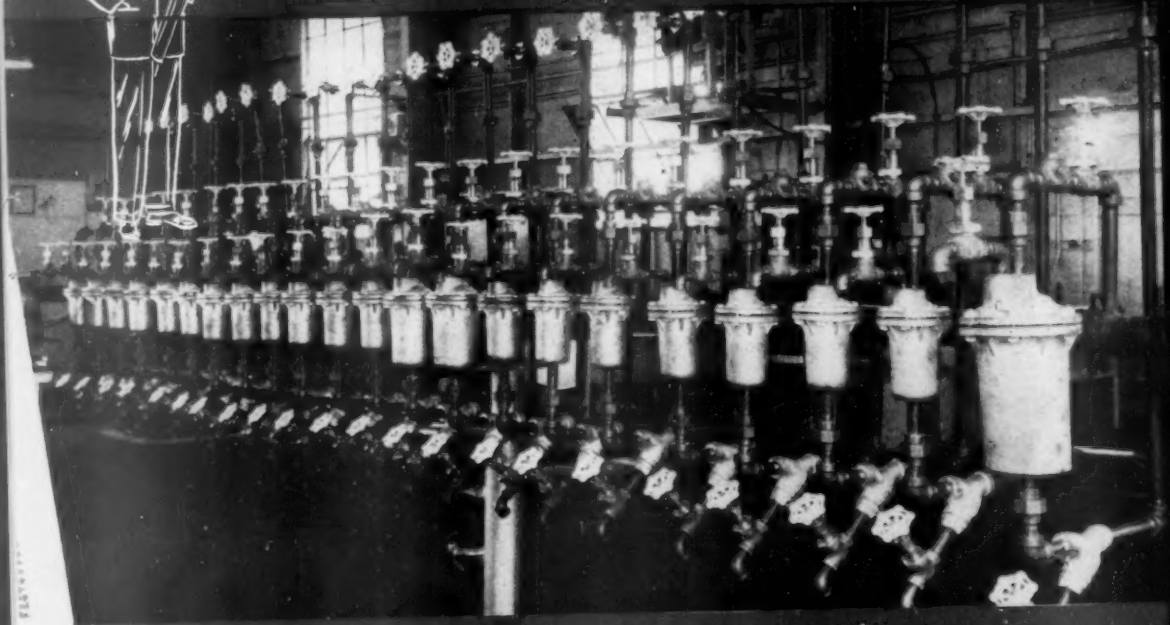
INSTRUMENTATION

FACTORIES IN THE UNITED STATES, CANADA, AND ENGLAND


ARMSTRONG
STEAM TRAPS
HERE'S AN EXAMPLE of how Armstrong data help you select the right size trap for the job.
Armstrong trap capacity figures are based on literally hundreds of tests under actual operating conditions with condensate at steam temperature. The chilling effect of flash steam through the orifice as well as the back pressure created by flash steam entering the return line are carefully taken into account. Only after these factors were used, as they do in actual installations in both the inlet and discharge lines also were reflected in the results.
If the trap capacity ratings had been based on cold water tests which produce no flash steam, they would be much too high. Orifice sizes also are too large. Consequently, pipe friction and other factors which affect the capacities have been overlooked. Capacities figures for Armstrong Traps are based on actual Capacity Ratings because only these reflect actual capacities on hot condensate.
Slide rule calculations of trap capacities have never been conservative.
WHEN YOU SPECIFY A STEAM TRAP you are specifying condensate handling capacity. When you use Armstrong Selection Data and specify Armstrong traps YOU KNOW that you are getting the right trap for the job.
Armstrong traps last longer, too—are less maintenance. Each trap is individually guaranteed to give complete satisfaction.
CAPACITY CHART
The black "sawtooth" curves on this chart show actual trap capacities (not theoretical discharges) using maximum diameter orifices at pressures shown. The brown extensions of these curves to the left show the capacities of the same orifices at pressures below the maximum for which each vertical step in the black curves is set. The next smaller size orifice is supplied. The orifice diameters in fractions of inches are shown in the small circles.
POUNDS OF CONDENSATE PER HOUR—ACTUAL CAPACITY OF TRAP, CONTINUOUS DISCHARGE
216
215
214
212
DIFFERENTIAL TRAP, LBS. PER SQ. IN.
Black curves
The heavy black "sawtooth" curves on the Capacity Chart show the capacities of Armstrong Traps under actual operating conditions as determined by hundreds of tests. In these tests temperature of condensate at steam temperature corresponding to the test pressure was maintained. The chilling effect of flash steam through the orifice as well as the back pressure created by flash steam entering the return line are carefully taken into account. Only after these factors were used, as they do in actual installations in both the inlet and discharge lines also were reflected in the results.
If the trap capacity ratings had been based on cold water tests which produce no flash steam, they would be much too high. Orifice sizes also are too large. Consequently, pipe friction and other factors which affect the capacities have been overlooked. Capacities figures for Armstrong Traps are based on actual Capacity Ratings because only these reflect actual capacities on hot condensate.
Brown curves
These curves show the capacities of their respective Traps at pressures below their maximum for which they are designed. For example: A No. 212 trap, with 5/32" orifice passes 1,000 lbs. per hour at 5 lbs. pressure. But it will handle 1,400 lbs. at 10 lbs. pressure—a little more than 1,400 lbs. per hour at 15 lbs. pressure.
One study of this Chart reveals that every trap capacity is governed by more than one orifice diameter. A 2" No. 212 trap with 5/32" orifice discharges 1,000 lbs. per hour at 5 lbs. pressure. But a 2" No. 212 with 1/4" orifice discharges 1,000 lbs. per hour at 15 lbs. pressure. Both orifices will work at 5 lbs. pressure, but the 5/32" orifice will not handle 1,000 lbs. per hour at 15 lbs. pressure. Thus, the 5/32" orifice is the "working" orifice at 5 lbs. pressure, but the 1/4" orifice is the "working" orifice at 15 lbs. pressure. Therefore, the 5/32" orifice is the restricting capacity orifice at 15 lbs. pressure when a 2" No. 212 is used in 2" pipe at 15 psig.
Trap selection
Steam trap selection is really very simple when dependable trap capacity data are available. Take these typical problems, for example:
1. MINIMUM PRESSURE, UNKNOWN CONDENSATE RATE.
Assuming you know:
The maximum pressure ..... 110 psig
The minimum pressure ..... 100 psig
Pressure drop ..... 10 psi
Weight of condensate ..... pounds per hour
Safety Factor ..... 3 to 1
Then, use 3 x 10 = 2700 lbs. as the continuous discharge capacity required. Refer to the Capacity Chart and follow the 100 lb. pressure line until the 2700 lb. capacity point is reached. This is between the No. 212 and No. 214 sizes. If a No. 212 trap is selected, the safety factor would be less than 3 to 1 which would not be satisfactory. If the No. 214 is thought by the Engineer to be too large, the No. 212 trap would be satisfactory under the conditions given. Therefore, the No. 214 trap would have a safety factor of 3 to 1.
2. CONSTANT PRESSURE, VARIABLE CONDENSING RATE
Where the steam pressure remains constant, but the condensing rate varies, determine if possible the minimum load per hour. Refer to the Capacity Chart and select a trap with a capacity less than average rate.
Don't Forget—
When using the Capacity Chart for selection of the correct size trap for your job:
1. First determine pressure differential at the trap—see page 21.
2. Determine the accurately as possible the condensate load in pounds per hour—see pages 21 and 23-24.
3. Use the correct Safety Factor—see pages 21 and 24 through 34.
4. Don't skimp on trap capacity or the required safety factor. Given the exact conditions, select the largest size.
3. VARIABLE PRESSURE CONDITIONS.
Where there is a wide variation in the steam pressure carried, and the condensing rate is unknown, select the pressure at the trap which will produce the greatest differential. Every effort should be made to determine the actual pressure at the trap.
Important Not On Forged Steel Pressure Ratin
Fig. 11—An Armstrong trap will operate satisfactorily at any pressure lower than that for which it is rated. If pressure is higher than shown in the Capacity Chart for the orifice used at the Capacity Chart for the orifice used at the lowest pressure, select the next smaller orifice—in the case of higher pressure differentials. The working pressure is used here as changed on the top of the chart number.
Pages 22 and 23 of the Armstrong Steam Trap Book
You're getting a known quantity when you specify
ARMSTRONG

# No trial and error on that job . . . .

## ARMSTRONG TRAP DATA are Reliable



THE most carefully calculated installation of steam-heated processing equipment will fail to deliver full output if the steam traps do not have adequate condensate and air handling capacity. When this happens an important part of the capital investment in plant and equipment is wasted.

After you have figured the amount of steam that will be condensed, you need data on:

*Condensate Capacity*—use theoretical, not estimated, nor cold water, but actual test findings with traps discharging condensate at steam temperature (see the discussion on the left-hand page).

*Trap Capacity Safety Factor*—or ratio between continuous discharge capacity and actual amount of condensate to be handled. These may run from a low of 2 to 1 or as high as 8 to 1. Armstrong data tells you just what safety factor to use to obtain adequate air venting capacity and maximum heat transfer.

Armstrong trap data helps you get traps "big enough" for the job, but not too big; assures you maximum operating efficiency; eliminates corrections after installation. For traps and trapping assistance call your nearby Armstrong Factory Representative.

**ARMSTRONG MACHINE WORKS**
868 Maple St., Three Rivers, Michigan

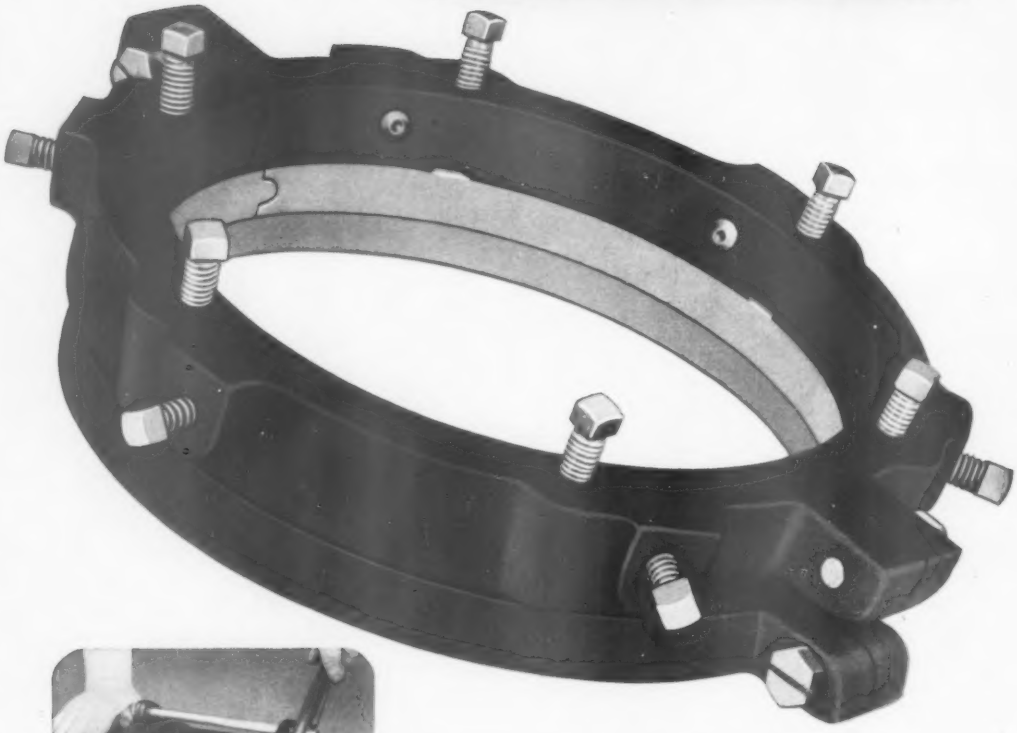
Left—Side Inlet—Side outlet traps for pressures to 250 lbs. for steam.

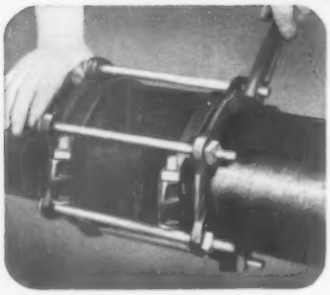
Left—Bottom Inlet—Top outlet traps for pressures to 250 lbs. for steam.

**Send for the NEW 44-page Steam Trap Book**—
Including 14 pages of data on how-to size traps for nearly every type of equipment—free, no obligation.

# STEAM TRAPS

# FOR THREAD LEAKS AT FITTINGS





FOR EVERY TYPE OF COLLAR LEAK

SKINNER-SEAL COLLAR LEAK CLAMP, with its sealed *gasket* and massive construction, stops every type of collar leak.

**SKINNER-SEAL PIPE JOINT CLAMP** stops leaks at joints where pipe is screwed into a fitting. Any temperature — pressures up to 2,000 pounds. A permanent repair — it saves the cost of tearing out and renewing leaky fittings. Prevents shut-downs. This clamp, constantly improved over the years, has been serving the industry for over half a century. In stock at all oil supply stores!

M. B. SKINNER COMPANY, SOUTH BEND 21, IND., U. S. A.

PIPE JOINT CLAMP
COLLAR LEAK CLAMP

**SKINNER-SEAL**

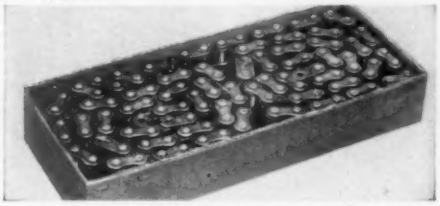
## CHAIN ASSEMBLY...CHAIN REPAIR

# THERE'S NOTHING TO IT!

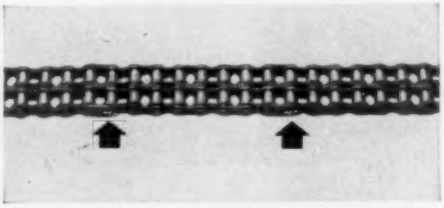
### WITH IMPROVED BALDWIN ASSEMBLY RIVETED ROLLER CHAIN

When it comes to assembly, disassembly or repair of roller chain either at the rig or in the supply store, the improved Baldwin Assembly is your time-saving, money-saving, trouble-saving, temper-saving answer. There's virtually nothing to it. Here's all you do:

### TO TAKE THE CHAIN APART

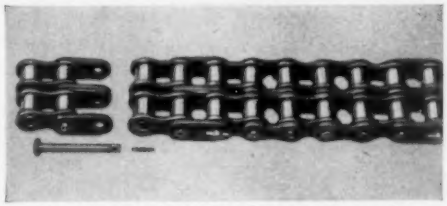


**1** You buy Baldwin Assembly Chains in a packaged unit —a 10-foot strand in every box. Each chain is made up of sections of varying lengths joined by single coupler pins. Stretch out the assembled chain.



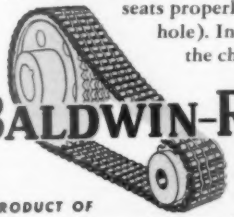
**2** Locate and mark the coupler or couplers to be disconnected. Their distinctive straight edge side plates, locking pins and washer heads make them easy to locate.

**3** Remove locking pin and drive flatted end of the coupler pin out of its side plate. Then tap it out the rest of the way with a drift pin. Before driving out the pin, back up the opposite side of chain with hammer or vise grip pliers to avoid springing the side plates.



**4** That's how easy it is to take this chain apart. If a section you need is in the middle of the strand...just remove the coupler pin on either side of the section desired.

**TO REASSEMBLE THE CHAIN.** To couple this chain, just line up the free end of the coupler link with the adjacent roller link. Back up the link with hammer or vise grip pliers. Drive in the pin (being sure the flatted end seats properly in the flatted side plate hole). Insert the locking pin, and the chain is now reassembled.



**BALDWIN-REX®**
**ROLLER CHAINS**

*A PRODUCT OF*
**Chain Belt COMPANY**
*OF MILWAUKEE*

**It will pay you to investigate the Improved Baldwin Assembly. You'll find it will simplify your chain problems and save you real money. Ask about it at your supply store or use the coupon to send for Bulletin 52-3. Baldwin-Rex Oil Field Sales Offices located in New York • Tulsa • Dallas • Houston • Midland • Los Angeles.**

**Chain Belt Company** 52-413A
**4619 W. Greenfield Ave.**
**Milwaukee 1, Wis.**
***Please send me Bulletin 52-3.***

*Name*.....

*Company*.....

*Address*.....

*City*.....*State*.....

*They did what you can do to produce more*

# How to get high power dependability without paying for standby capacity

When Sohio modernized and expanded the Lima refinery they needed a highly dependable power system. But they didn't want to pay for emergency stand-by capacity, a common way to achieve reliability. So engineers from Sohio, Dingle-Clark Co., and Westinghouse worked out an ingenious solution based on a sound basic principle.

### *Ingenious Controls Instead of Transformers*

The basic principle is this: that you don't need *absolutely continuous power* for high reliability, but rather *speedy restoration of service* after disturbances do occur. So instead of providing for expensive extra transformer capacity, they developed a control system that automatically and rapidly clears trouble. And a power loss up to four seconds doesn't slow down the plant.

### *Devastating Tornado Didn't Stop Operation*

The results of this sound planning were soon evident. Nine months after installation, a devastating tornado hit Lima and knocked out one of the two power lines serving the plant. The two key motors (catalytic cracker blower drive) were thrown out of synchronization. But both were immediately restarted by the ingenious control system. Then a second fault knocked them out again and one motor restarted to keep the process going all through the disturbances.

### *Disturbances are Cleared Automatically*

In the first nine months of operation, there were 12 disturbances which affected these key blower motors. On ten occasions, the controls automatically restarted the motors. The other two times, the motors were restarted manually. Numerous other disturbances have failed to affect plant operation in *any* way.

### *Call Westinghouse Early On Your Next Project*

The key to continuous power is good planning. Westinghouse would like to do this kind of planning with you. Call us in *early* when *you* build, expand or modernize. Westinghouse Electric Corp., P. O. Box 868, Pittsburgh 30, Penna.

HOW SOHIO GOT HIGH RELIABILITY AT LOW COST

To keep the costs down, they built very little spare capacity into the system. Thus if there is a momentary outage, the load must be reapplied in segments. The operation is controlled by Westinghouse high-voltage switchgear, shown at left.

The big power users are the blower motors. If power outage occurs, they're automatically taken off the line by a clever "under-frequency" relay so that the rest of the plant can start up when the fault is cleared. Then in less than one minute, one of the blower motors restarts automatically. The plant keeps operating through the disturbance.

J-94906

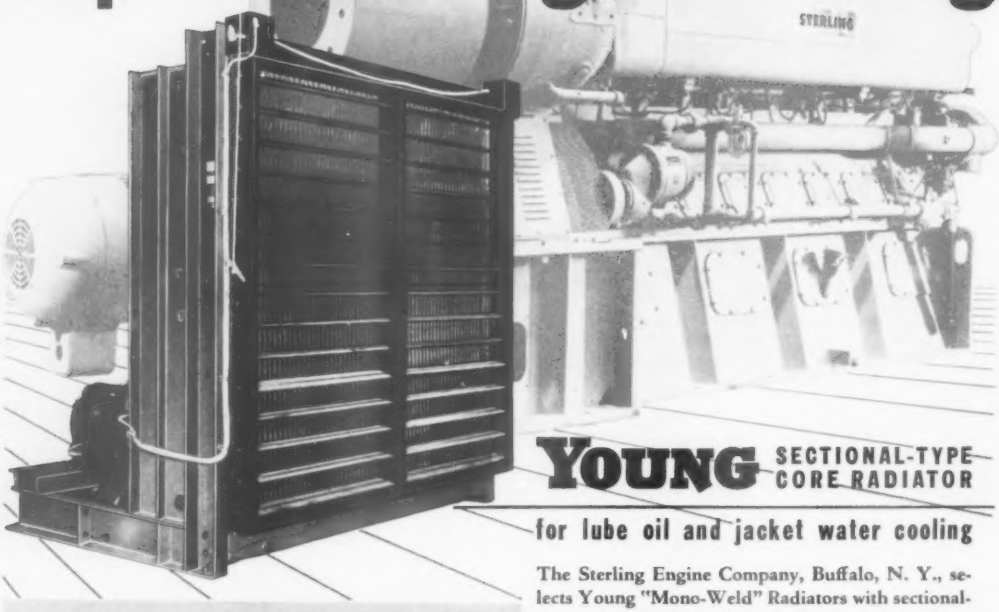
YOU CAN BE SURE...IF IT'S

Westinghouse

EQUIPMENT FOR THE PETROLEUM INDUSTRY

MEETING TODAY'S POWER NEEDS WITH

# dependable engine cooling



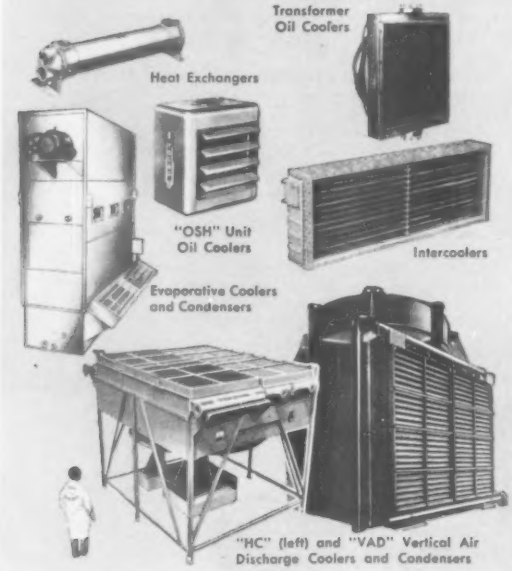

## YOUNG SECTIONAL-TYPE CORE RADIATOR

### for lube oil and jacket water cooling

The Sterling Engine Company, Buffalo, N. Y., selects Young "Mono-Weld" Radiators with sectional-type cores for dependable and economical cooling of lube oil and jacket water for a number of Diesel-generator units built for the Corps of Engineers, U. S. Army. These Young Radiators dissipate 2,250,000 Btu's per hr. for each of the 500-kw semi-portable Diesel generator sets.

As illustrated, many Young Heat Transfer products are serving in stationary, portable and stand-by power plants, in oil-field pipeline compressor and booster stations, etc. One-piece or sectional-type core Radiators are available in various sizes, dissipating from 70,000 to 3,250,000 Btu's per hr. For details, see your Young Distributor or write direct.

**OTHER YOUNG ENGINEERED PRODUCTS FOR POWER GENERATING PLANTS**


Transformer Oil Coolers
Heat Exchangers
"OSH" Unit Oil Coolers
Intercoolers
Evaporative Coolers and Condensers
"HC" (left) and "VAD" Vertical Air Discharge Coolers and Condensers

## YOUNG

Heat Transfer Products for Automotive and Industrial Applications.

Young Quality

Heating, Cooling, Air Conditioning Products for Home and Industry.

**YOUNG RADIATOR COMPANY**

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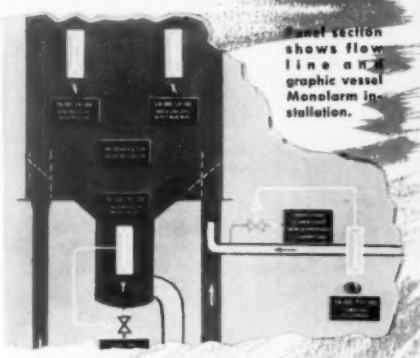
*Other Representatives in Principal Cities*

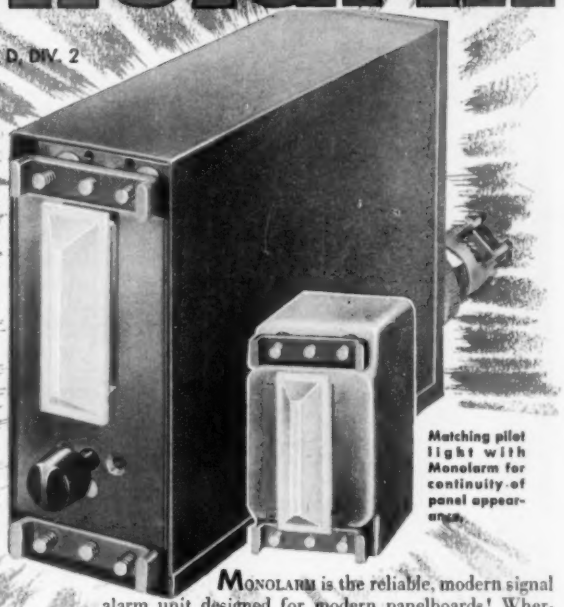
*Announcing . . .* **R&S Monolarm®**

CLASS I, GROUPS C & D, DIV. 2

**. . . the Compact signal alarm unit ideal for flow line and graphic panels**



Panel section shows flow line and graphic vessel Monolarm installation.



Matching pilot light with Monolarm for continuity of panel appearance.

MONOLARM is the reliable, modern signal alarm unit designed for modern panelboards! Wherever instrumentation space is at a premium—wherever flow lines and graphic vessels must tell their visual processing story without interference from bulky signal alarms—this exclusive R & S development takes over with minimum space on front and back of panels.

Monolarm offers instant warning against any abnormality occurring in a processing operation at any time—and safeguards against expensive losses of production and materials. Should any abnormality occur, the normal light ceases to shine . . . the alarm light flashes rapidly on and off . . . also an external howler, if used, is sounded. Acknowledgment by the operator must be made by turning the re-set switch . . . the alarm light then assumes a steady state until the condition is remedied . . . then Monolarm automatically resumes its normal indication.

Several hundred highly successful installations are already completed. Monolarm is now available on your order.

## *Advantages of* R&S MONOLARM

1. A single narrow bezel and button fits into a flow or graphic line diagram without interrupting the continuity of the design story.
2. Occupies minimum back-of-panel mounting space.
3. Lighting indications in two or three colors on *one* bezel.
4. Relamping is quick and easy from the front of the panel.
5. Instantaneous connect and disconnect of the power supply cable to Monolarm is provided by an interlocking switch receptacle and plug.
6. Maximum safety is afforded by interlocking the plug with the hermetically sealed switch, making it impossible to insert or withdraw plug under load. When the polarized plug is inserted into the receptacle and the plug shell is turned clockwise, it turns the switch to the "On" position and vice-versa.
7. Hermetically sealed plug-relays instantly removable if replacement is necessary.
8. Time delay circuit available to counteract turbulence and vibration when abnormal condition is reached.

• *Write for Sales Data Sheet #21253— 13*

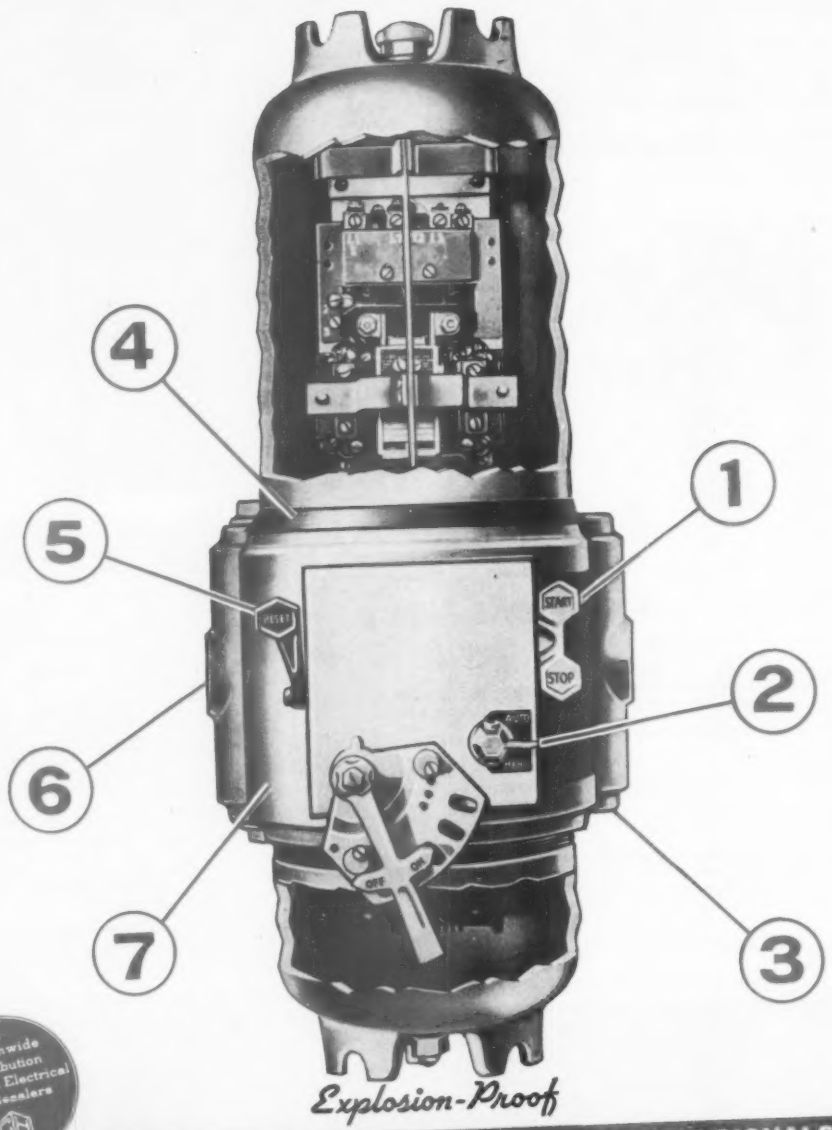
**RUSSELL & STOLL COMPANY, INC. • 125 BARCLAY STREET, NEW YORK 7, N. Y.**

**RUSSELL & STOLL**

PRECISION BUILT ELECTRICAL EQUIPMENT . . . SINCE 1907

# 7 important NEW features

## ... to the many basic advantages of




*Explosion-Proof*

A Nationwide Distribution Through Electrical Wholesalers

CONDULETS • TRAFFIC SIGNALS

# have been added
# CROUSE-HINDS Type EPC
## motor starter and circuit breaker CONDULET *

### You get all of them on the Model M52

Model M52 EPC is the most flexible explosion-proof line starter and circuit breaker enclosure ever produced. The addition of 7 new features to the proven basic advantages of the EPC construction assures the greatest ease of installation and maintenance.

The exclusive basic advantages of the EPC Condulet have made it the world's leading enclosure for housing motor starters, circuit breakers and combinations for use in hazardous locations.

The basic advantages are:

EASY INSTALLATION . . . The use of a strong light-weight aluminum alloy and the unique three-section design makes it practical for an electrician and his helper to install the largest housing without the use of costly lifting equipment. The internal devices can be easily removed for pulling in the wires.

THREADED JOINT CONSTRUCTION . . . All joints are threaded. All operating shafts and bushings are thread-in-thread construction. This insures maximum safety, easy inspection and maintenance, and maximum corrosion protection.

FLEXIBILITY . . . A large number of different enclosures can be assembled from the wide variety of sizes of bodies and covers. They are not only used for circuit breakers and starters but have proven adaptable for many other types of electrical equipment. The body has numerous conduit hubs for flexibility of installation.

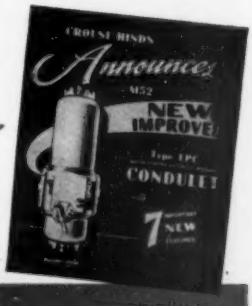
COST AND TIME SAVINGS . . . The outstanding advantages of the unique EPC Condulet over conventional explosion-proof enclosures all add up to lower installed cost and lower maintenance cost.

All of these advantages have been available for years.

*Now Crouse-Hinds offers you 7 new improvements to underline the basic advantages of type EPC Condulets and to save you more dollars and more man-hours than ever before.*

1. **Built-in Push button stations** available on line starters and combinations of line starters with circuit breakers — START — STOP, FOR — REV — STOP and HIGH — LOW — STOP stations for regular, reversing, or two-speed starters.
2. **Built-in selector switch** is available on line starters and combinations of line starters with circuit breakers. Normally supplied marked HAND — OFF — AUTO or JOG — RUN — OFF, three-position style. Two-position selector switch or combinations of selector switch with START — STOP station can be supplied.
3. **Back conduit entrance** can be supplied by drilling and tapping the boss in the center of the back . . . in addition to the four regular top and bottom hubs.
4. **Protective Neoprene gasket** is available for the upper cover joint. Where EPC Condulets are exposed to unusually severe weather or corrosive conditions, this gasket provides additional protection.
5. **A new RESET lever with threaded shaft,** rotating within a threaded bushing, provides easier and more positive operation of the reset mechanism.
6. **Horizontal through-feed conduit entrances** are provided by drilling and tapping bosses on the sides of the Condulet body.
7. **Greater ease in wiring** is provided by increased height in the center body section and by universal use of open framework mountings for circuit breakers and starters in the new model M52 EPC Condulets.

**Model M52 Type EPC Explosion-Proof Condulet in 7, 9, and 11-inch body sizes**




Send for YOUR copy of Bulletin 2634 →

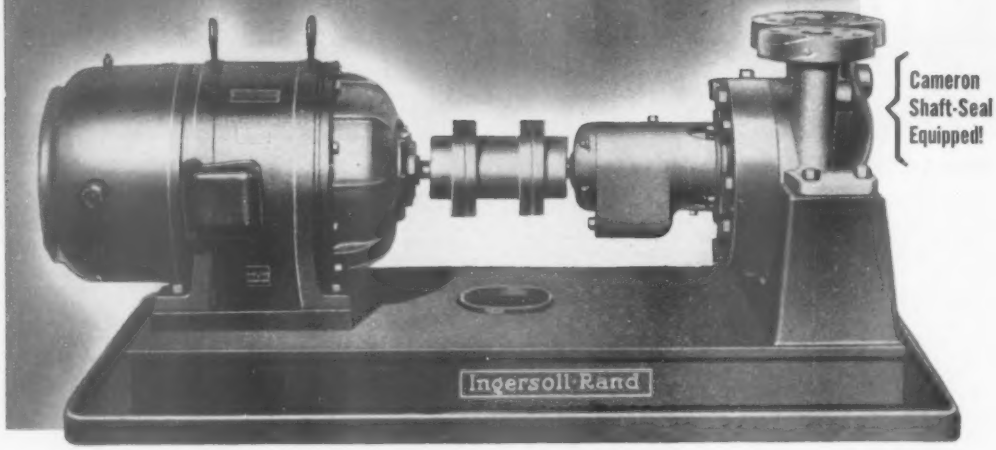
* CONDULET is a coined word registered in the U. S. Patent Office. It designates a product made only by the Crouse-Hinds Company.

**CROUSE-HINDS COMPANY**
Syracuse 1, N. Y.

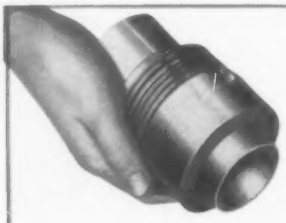
OFFICES: Albuquerque – Birmingham – Boston – Buffalo – Chicago – Cincinnati – Cleveland – Dallas – Denver – Detroit – Houston – Indianapolis – Kansas City – Los Angeles – Milwaukee – Minneapolis – New York – Philadelphia – Pittsburgh – Portland, Ore. – San Francisco – Seattle – St. Louis – Tulsa – Washington. RESIDENT REPRESENTATIVES: Albany – Atlanta – Baltimore – Charlotte – New Orleans – Richmond, Va. Crouse-Hinds Company of Canada, Ltd., Toronto, Ont.

**AIRPORT LIGHTING • FLOODLIGHTS**

# For the First Time...




# A REFINERY AND PROCESS PUMP DESIGNED AROUND A MECHANICAL SEAL



**CAMERON SHAFT-SEAL**
***The answer to tough stuffing box problems.***

A stationary sealing face of carbon and a rotating seal ring of stellited steel constitute the heart of the Cameron Shaft-Seal. Balanced sealing areas control contact pressure between the sealing faces, effectively preventing leakage without undue wear of the rotating fit. In difficult sealing jobs, the Shaft-Seal succeeds where complicated packed stuffing box arrangements have failed.

**Built-in Cameron Mechanical Shaft-Seal reduces liquid losses and stuffing box maintenance in this SFLA pump line!**

The Cameron Shaft-Seal is an Ingersoll-Rand development that has demonstrated its dependability in thousands of process installations the world over since its introduction in 1928. Now, this same Shaft-Seal is built-in as an integral part of these pumps—*at no extra cost*. Use of the Shaft-Seal efficiently stops liquid losses and reduces stuffing box attention to a minimum.

Designed for handling light refinery liquids at moderate temperatures, SFLA-MFLA-HFLA pumps are built in five sizes from 1 to 4 inches for low, medium and high head applications. Top discharge is standard, with top or end suction nozzles available. Capacities to 1000 gpm and pressures to 600 psi. Write, or ask your Ingersoll-Rand representative for full details.

Ingersoll-Rand

Cameron Pump Division 699-10
11 Broadway, New York 4, N. Y.

COMPRESSORS • CONDENSERS • ROCK-DRILLS • AIR & ELECTRIC TOOLS • PUMPS • GAS & DIESEL ENGINES

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HAMMEL-DAHL

# Entire Process Plants, Pipelines and Pilot Units

. . . in all parts of the world, are now completely equipped with HAMMEL-DAHL AUTOMATIC CONTROL. Superior quality, experienced engineering, honest workmanship, *plus* lower maintenance and operating costs have convinced many engineers.

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MANUFACTURED AND DISTRIBUTED BY: *Canada* — The Guelph Engineering Co., Ltd., Guelph, Ontario
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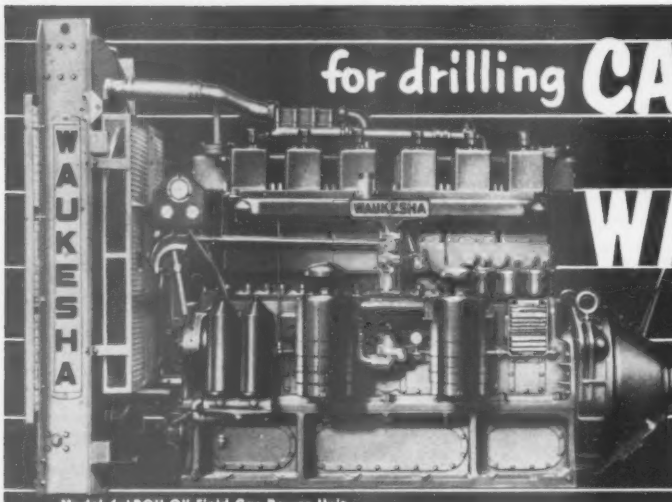
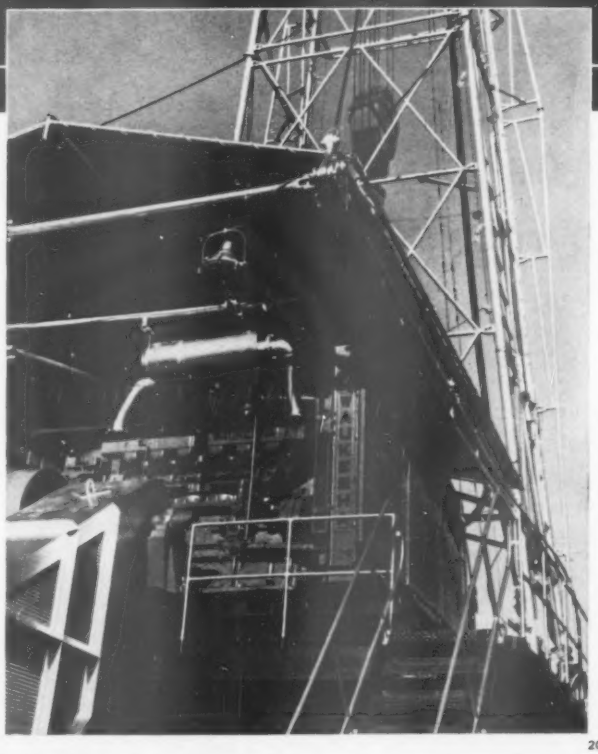
# for drilling CAPACITY...




# WAUKESHA POWER

**Model 6-LROU Oil Field Gas Power Unit**
Six cylinder, 8½-in. bore x 8½-in. stroke, 2894 cu. in. displacement, 390 hp max. at 1000 rpm on natural gas.

*See Our Exhibit*
**OIL SHOW**
**TULSA** MAY 14-23



● Look at the rig's power plant. There's your proof of production. The capacity is there . . . the speed is there . . . the flexibility is there—with Waukesha Giant Sixes! Oil field favorites for over 20 years!

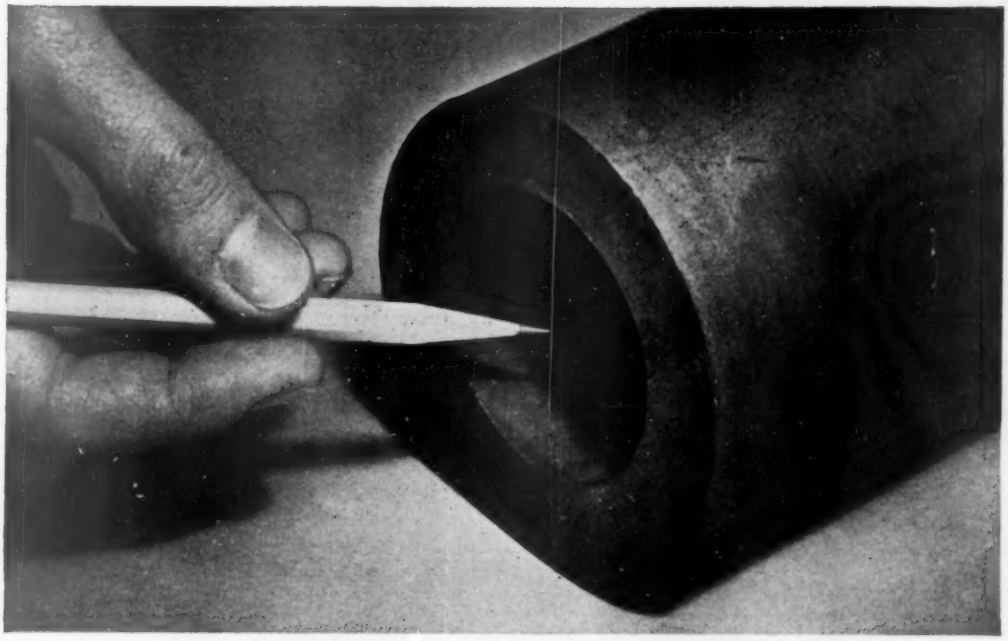
Each is a complete, independent power plant. With a radiator cooling system, self-contained lubricating system, heavy-duty clutch and power take-off. Or compounded for super power! High compression overhead valve, 6-cylinder, 2894 cu. in. gas engine—vertical design with box base, separate crankcase and separately mounted three-bore cylinder blocks. Renowned for reliability!

New *Oilwell* 76 rig shown has 3 Waukesha Giant Sixes. Bulletin 1560 tells *why*.

**WAUKESHA MOTOR COMPANY, WAUKESHA, WIS.**
NEW YORK TULSA LOS ANGELES

203

# WAUKESHA
*Diesel* **OIL FIELD POWER** *Gas*



# If you make hollow parts, here's where you can save steel and machining time

THE hole is already there when you use Timken® seamless tubing. Often, you can go right into finish boring as your first production step. You save machining time. Screw machine stations can be released for other operations. You get added machine capacity without additional machines.

By using Timken seamless tubing in place of bar stock, you save steel, too. Scrap loss is cut. You get more parts per ton of steel. And to help you save even *more* steel, the Timken Company offers a tube engineering service which recommends the most economical tube size for your job—guaranteed to clean up to your finished dimensions.

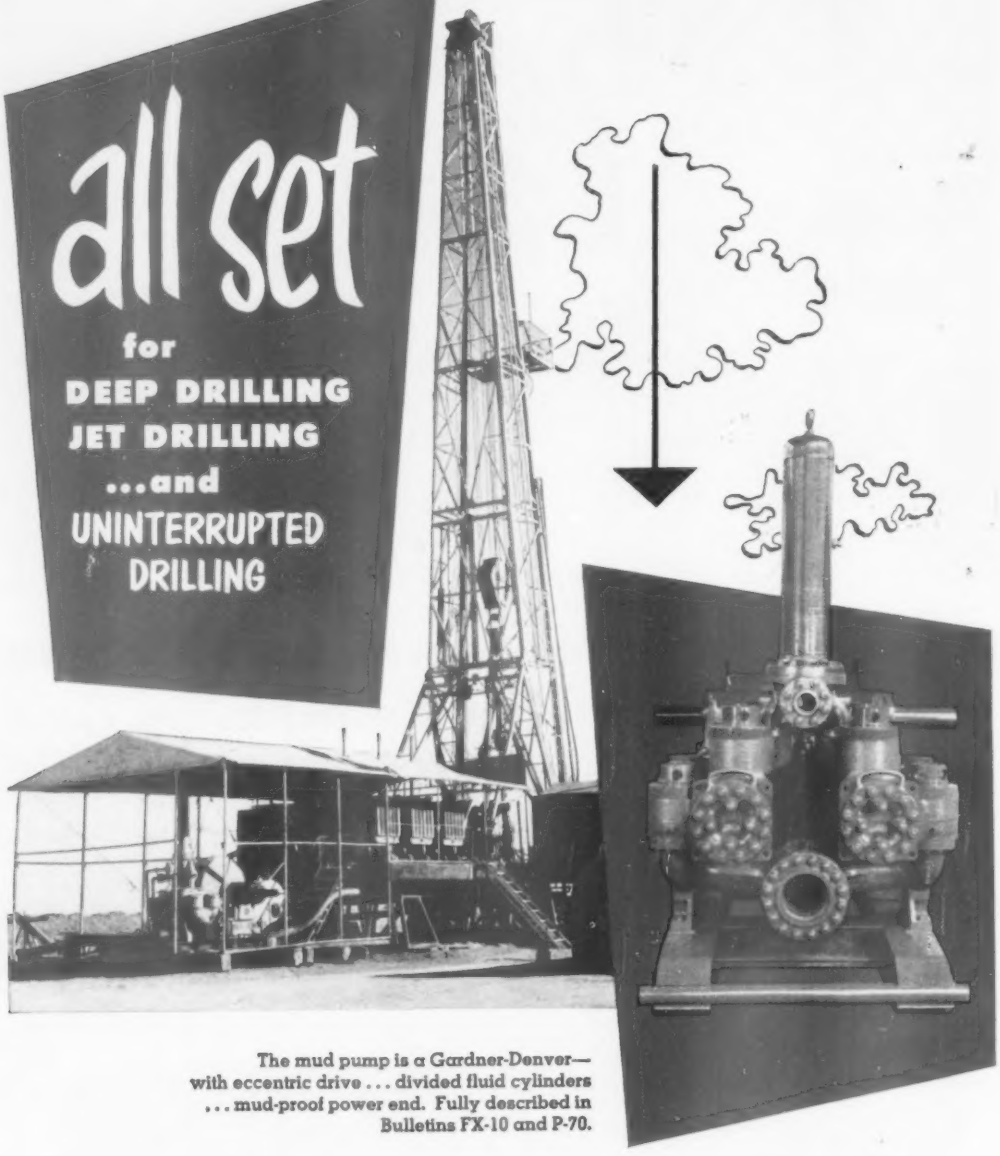
Timken seamless tubing gives you high internal quality because the piercing process by which it is made is basically a forging operation. Result: a uniform spiral grain flow for greater strength and a refined grain structure which brings out the best quality of the metal. And the Timken Company's rigid control keeps this quality uniform from tube to tube and heat to heat. The Timken Roller Bearing Company, Steel and Tube Division, Canton 6, Ohio. Cable address: "TIMROSCO".

YEARS AHEAD—THROUGH EXPERIENCE AND RESEARCH

SPECIALISTS IN FINE ALLOY STEELS, GRAPHITIC TOOL STEELS AND SEAMLESS TUBING

# all set

for
DEEP DRILLING
JET DRILLING
...and
UNINTERRUPTED
DRILLING



The mud pump is a Gardner-Denver—
with eccentric drive . . . divided fluid cylinders
. . . mud-proof power end. Fully described in
Bulletins FX-10 and P-70.

SINCE 1859

GARDNER-DENVER

Gardner-Denver Company, Quincy, Illinois
In Canada: Gardner-Denver Company (Canada), Ltd.,
14 Curity Avenue, Toronto 13, Ontario

Dallas • Houston • Tulsa • St. Louis • Los Angeles
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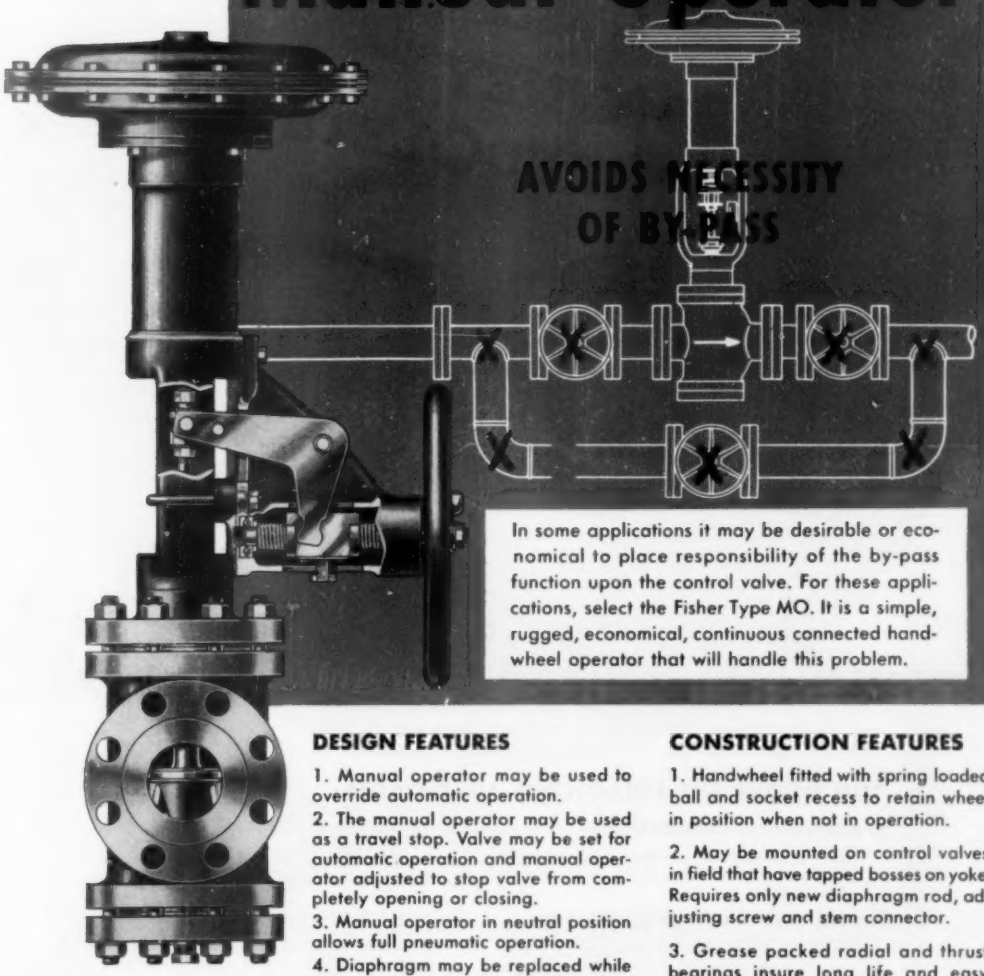
THE QUALITY LEADER IN COMPRESSORS, PUMPS AND ROCK DRILLS

FISHER®

# Type MO Manual Operator




In some applications it may be desirable or economical to place responsibility of the by-pass function upon the control valve. For these applications, select the Fisher Type MO. It is a simple, rugged, economical, continuous connected handwheel operator that will handle this problem.

Fisher Type 57-T diaphragm motor valve with side mounted Type MO handwheel operator in section.

## DESIGN FEATURES

1. Manual operator may be used to override automatic operation.
2. The manual operator may be used as a travel stop. Valve may be set for automatic operation and manual operator adjusted to stop valve from completely opening or closing.
3. Manual operator in neutral position allows full pneumatic operation.
4. Diaphragm may be replaced while manual operator is used to control flow of fluid.
5. Manual operator is mounted on side of control valve for accessibility and ease of operation.

## CONSTRUCTION FEATURES

1. Handwheel fitted with spring loaded ball and socket recess to retain wheel in position when not in operation.
2. May be mounted on control valves in field that have tapped bosses on yoke. Requires only new diaphragm rod, adjusting screw and stem connector.
3. Grease packed radial and thrust bearings insure long life and easy operation.
4. Handjack operating screw constructed with pitch to give adequate operating power.

FISHER

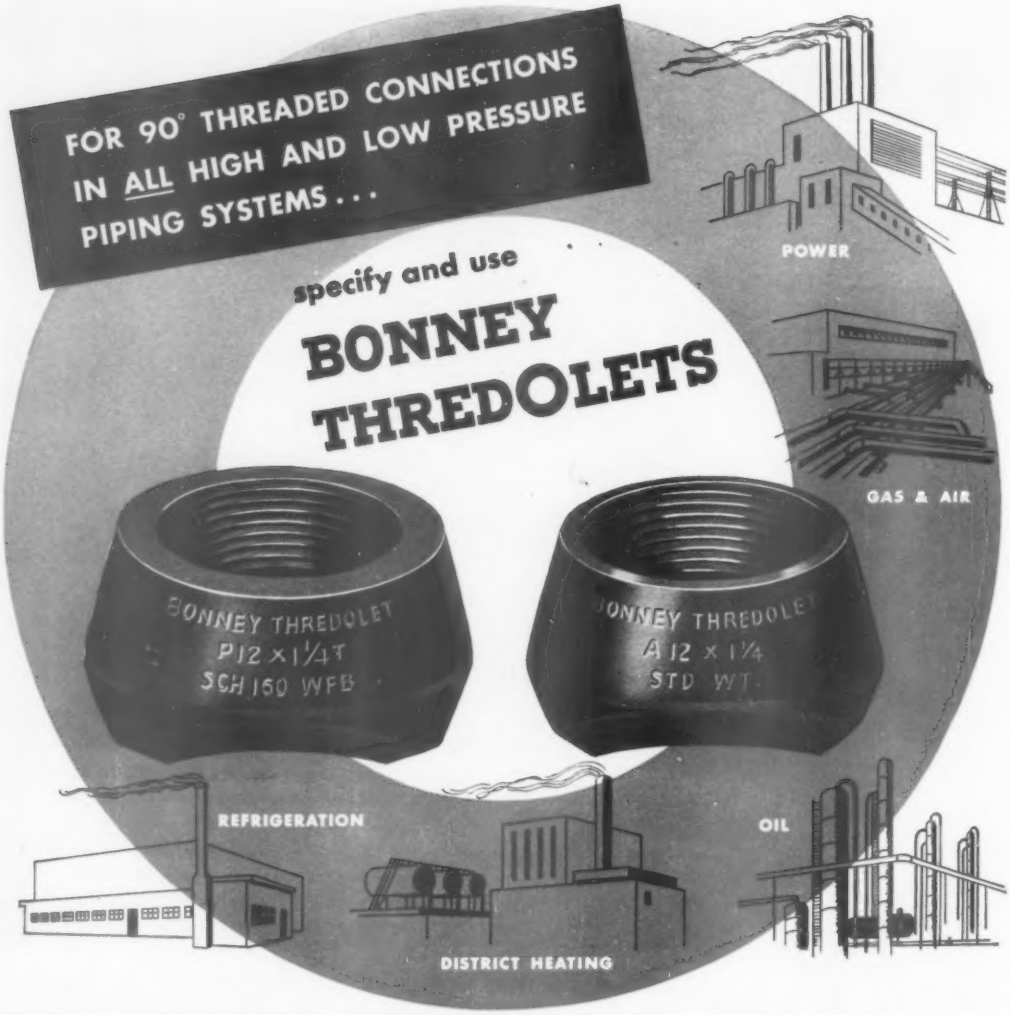
**FISHER GOVERNOR COMPANY, Marshalltown, Iowa**

WORLD LEADER IN RESEARCH FOR BETTER PRESSURE AND LIQUID LEVEL CONTROL

FOR 90° THREADED CONNECTIONS IN ALL HIGH AND LOW PRESSURE PIPING SYSTEMS . . .

specify and use

# BONNEY THREDOLETS




## YOU DERIVE THE FOLLOWING ADVANTAGES:

**1. ACCELERATED FABRICATION—**
with ThredOlets no coupling preparation is necessary—you obtain the most economical type of construction.

**2. NEAT AND UNIFORM APPEARANCE—**
ThredOlets minimize variations caused by human element—you attain the best engineered type of construction.

**3. IMPROVED FLOW—**
ThredOlets provide a funnelled inlet—you achieve better performance and better piping system design.

**4. DIMENSIONAL STANDARDIZATION—**
with each ThredOlet installation, you have constant control of the critical center-of-run-pipe to face-of-outlet dimension.

*The Bonney WeldOlet Welding Fittings Catalog, No. W-3, provides complete engineering and dimensional data*
*Write for your free copy.*

**WELDING FITTINGS DIVISION**

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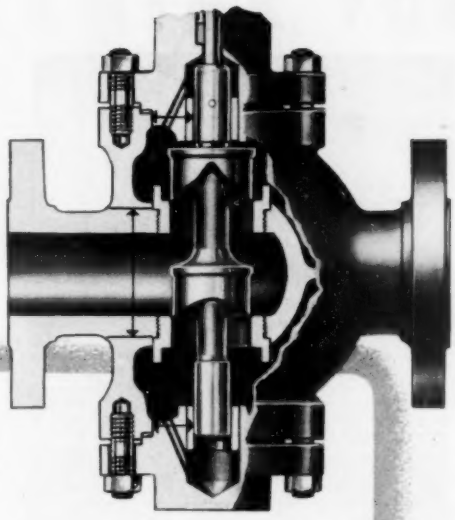
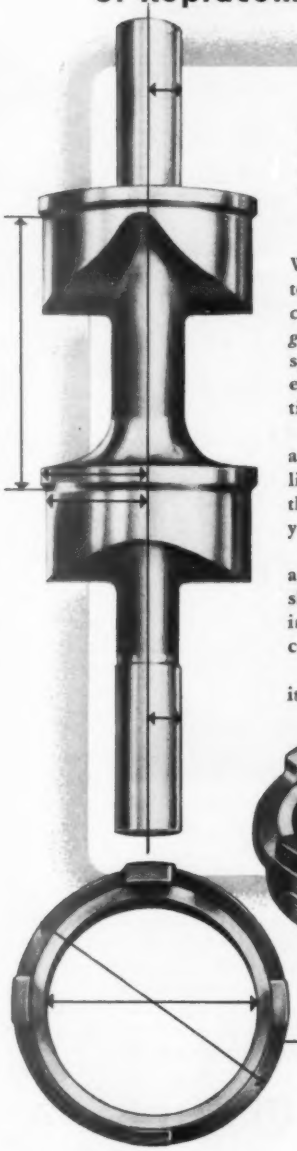
## In Masoneilan Control Valves the PLUS Quality Factor is

# Precise Uniformity

## of Replacement Parts





*Concentricity maintained within ±.0005" at points indicated insures accurate fit and perfect alignment.*

When you buy parts for replacement you have a right to expect to be able to install them without recourse to a machine shop for custom fitting. And when you use Masoneilan Control Valves you *get* parts that fit. For Mason-Neilan precision methods, using specially designed tools and gauges, plus rigorous inspection eliminate this maintenance man's headache and reduce costly time out of service.

Note the points where precise uniformity means accurate fit and alignment. By maintaining concentricity within very narrow limits at these points Mason-Neilan makes certain not only that the valve you buy will be in perfect alignment but that any parts you may install later will also be in perfect alignment.

This uniformity is checked during processing and assembly — and replacement parts are rechecked in master bodies before shipment. Moreover, these parts are covered with a plastic coating to insure that the finish will be protected from damage and corrosion during shipment or storage.

This PLUS quality factor, added to the other outstanding qualities of Masoneilan Control Valves, offers you valves that *cost* less — and *cost* not *price* is the valid comparison among similarly priced valves.

MASONEILAN

**MASON-NEILAN**

**REGULATOR CO.**

**1185 ADAMS STREET, BOSTON 24, MASS., U. S. A.**

A HIGH Q PRODUCT

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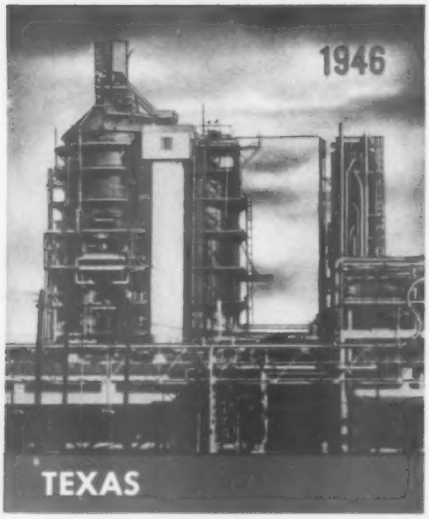
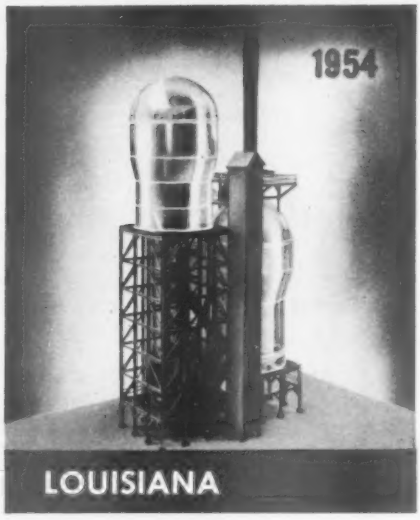





# FOUR FW CATALYTIC CRACKING UNITS

- **one customer**
- **one more proof of FW leadership in fluid catalytic cracking**

With a combined capacity of 147,000 barrels a day, these four Foster Wheeler catalytic cracking units represent an important contribution to the world's petroleum facilities. The first three units, each with a charging capacity of 25,000 bbl per day, are currently in operation. The fourth unit, with a capacity of 72,000 bbl per day total feed, is under contract and scheduled for completion in 1954.

**FOSTER WHEELER CORPORATION**
165 Broadway, New York 6, N. Y.

FOSTER WHEELER

# PRE-TESTED STAMINA FOR

## *HIGHER OUTPUT, LOWER MAINTENANCE*

### METALLOGRAPH PROVES THE SERVICE "EXTRAS" IN ATLAS "SUPER-LIFE" ROLLER CHAIN

Extra toughness for your heaviest shock loadings, extra wearability to slash your maintenance costs, and extra fatigue life to give you longer uninterrupted service! These extra values in every length of Atlas Roller Chain are pre-tested daily on the Atlas Metallograph, for proven performance year after year on your power transmission drives.

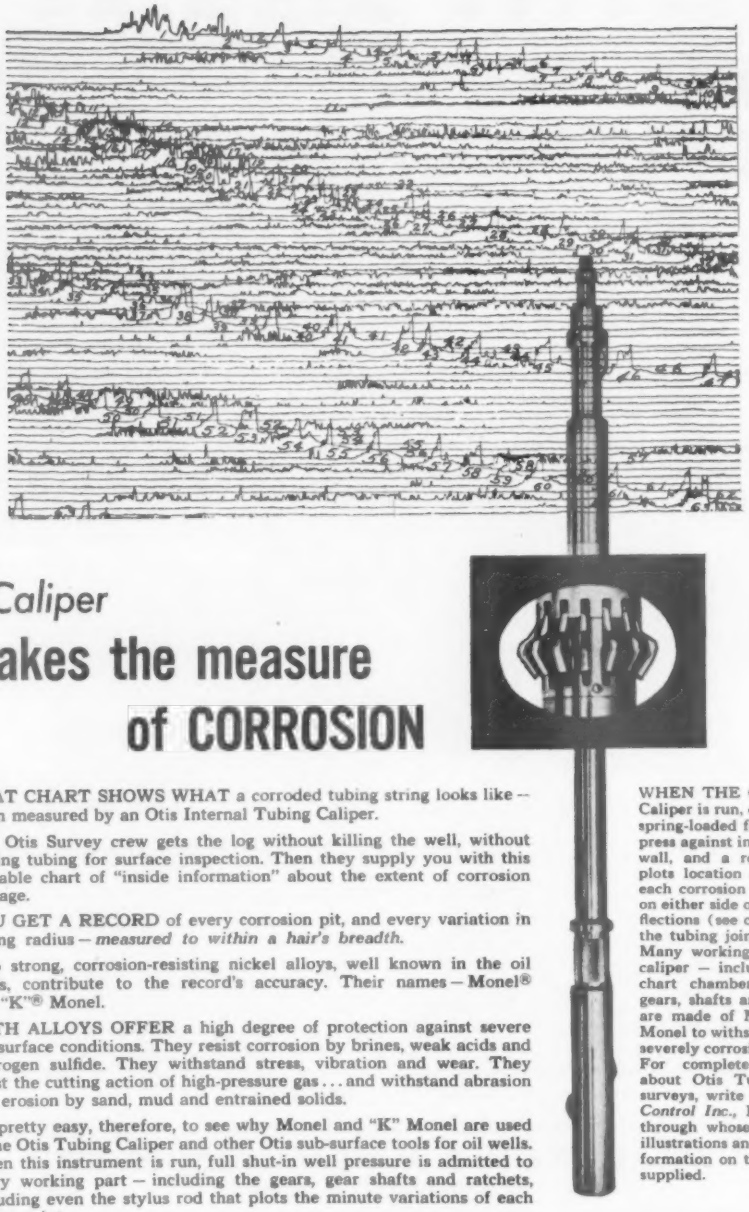
To give you smoother, trouble-free performance, the Metallograph stands guard over the stamina and toughness of every heat-treated part in Atlas Chain . . . checks the metallic properties that mean extra production at lower cost.

For full-rated speeds on all your machines, for longer wear and more economy, get the chain with the service "extras". . . . install Atlas Roller Chain on every drive. Send today for your copy of the fact-filled Atlas Catalog and Handbook.

**See Your Local Atlas Distributor for Quick Deliveries and Experienced Service**

**ATLAS CHAIN & MANUFACTURING CO.**
**PHILADELPHIA 24, PENNA.**

# ATLAS ROLLER CHAIN



## *Tubing Caliper*

# takes the measure of CORROSION

**THAT CHART SHOWS WHAT** a corroded tubing string looks like — when measured by an Otis Internal Tubing Caliper.

The Otis Survey crew gets the log without killing the well, without pulling tubing for surface inspection. Then they supply you with this valuable chart of "inside information" about the extent of corrosion damage.

**YOU GET A RECORD** of every corrosion pit, and every variation in tubing radius — *measured to within a hair's breadth.*

Two strong, corrosion-resisting nickel alloys, well known in the oil fields, contribute to the record's accuracy. Their names — Monel® and "K"® Monel.

**BOTH ALLOYS OFFER** a high degree of protection against severe sub-surface conditions. They resist corrosion by brines, weak acids and hydrogen sulfide. They withstand stress, vibration and wear. They resist the cutting action of high-pressure gas . . . and withstand abrasion and erosion by sand, mud and entrained solids.

It's pretty easy, therefore, to see why Monel and "K" Monel are used in the Otis Tubing Caliper and other Otis sub-surface tools for oil wells. When this instrument is run, full shut-in well pressure is admitted to every working part — including the gears, gear shafts and ratchets, including even the stylus rod that plots the minute variations of each feeler point.

Otis relies on the ability of Monel and "K" Monel to stand up when the going is tough. And stand up they do — in places where other materials often *fold* up!

**KEEP MONEL AND "K" MONEL IN MIND** when you run into problems involving metals for oil field use. And call on Inco's Technical Service for all the help you need. They have information readily available, and always welcome the opportunity of sharing it with you.

**WHEN THE OTIS** Tubing Caliper is run, closely spaced spring-loaded feelers (inset) press against inside of tubing wall, and a rotating stylus plots location and depth of each corrosion pit. Numbers on either side of coupling deflections (see chart) refer to the tubing joint in the well. Many working parts of the caliper — including internal chart chamber, stylus rod, gears, shafts and ratchets — are made of Monel or "K" Monel to withstand effects of severely corrosive conditions. For complete information about Otis Tubing Caliper surveys, write *Otis Pressure Control Inc.*, Dallas, Texas, through whose courtesy the illustrations and technical information on this page were supplied.

**Monel . . . "K" Monel**

*. . . YOUR PARTNERS IN PROGRESS*

INCO TRADE MARK

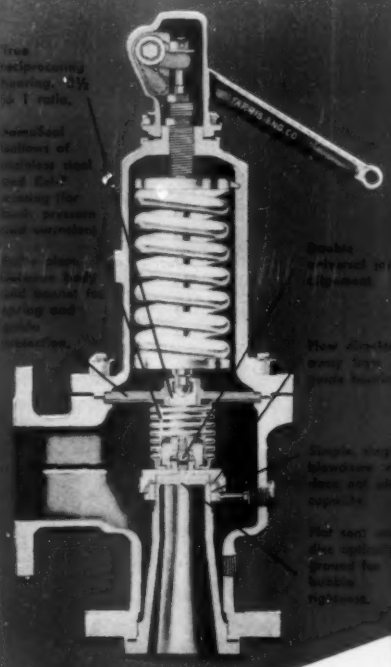
**The International Nickel Company, Inc.**

67 Wall Street, New York 5, N. Y.

# for economical positive* safety...

## BalanSeal and FarriSeal Safety-Relief Valves

*(Pat'd & Pat. Pending)*



Eliminate all risk of failure—failure that might cost lives or severe damage to equipment. Rely on the only safety-relief valves guaranteed to provide positive protection, 100% of the time, under all operating conditions. Farris safety-relief valves *can't* stick, plug or corrode because the critical working parts are completely isolated from the lading fluid—and they're unaffected by back pressures in the discharge manifold. These unique valves are more economical, too, because they permit higher downstream pressure with smaller discharge piping. In many installations this saving in piping costs amounts to as much as 15 times the cost of the valves. *You* can't go wrong with BalanSeal or FarriSeal Valves because *they* can't go wrong!

*Technical manual, 51B, a treatment on Back Pressure Piping and Surge characteristics and 76-page catalog is yours for the asking.*

* ASME-N.B. APPROVED
(Certified for Capacity)

*Representatives in all Principal Cities*

Farris
ENGINEERING CORPORATION
527 Commercial Avenue
PALISADES PARK, NEW JERSEY

*Affiliates:* Farris Flexible Valve Corp. • Farris Stacon Corp. • Farris HydroTorque Corp. • Farris HydroSeal Corp.

# Mack comes in costs go down

It happens all the time. A truck user finds that heavy loads, rigorous weather, or tough terrain are proving too much for the trucks he owns. Frequent breakdowns . . . interrupted output . . . excessive repairs—all conspire to boost his costs and cut his profit margin. Then—if he's smart—he switches to Mack six-wheelers.

And that's where he gets a real eye-opener. Because even under the most adverse hauling conditions—hub-deep mud, slippery sand or pitted rock-strewn ground—his Mack six-wheelers keep the big loads moving on dependable, time-saving, cost-cutting schedule.

The reason why? It's found in Mack's Balanced Bogie with exclusive Power Divider that assures positive traction no matter how tough the going. Acting normally as a true differential the Mack Power Divider delivers torque between the two bogie axles in proportion to wheel traction, thus eliminating useless wheel slippage and spinning.

Mack's Balanced Bogie and Power Divider combine with numerous other outstanding Mack features to give you the power, strength, traction and easy maintenance you need to handle the biggest loads—with greater profit to you. Your nearest Mack branch or distributor will gladly give you all the facts.

Mack TRUCKS

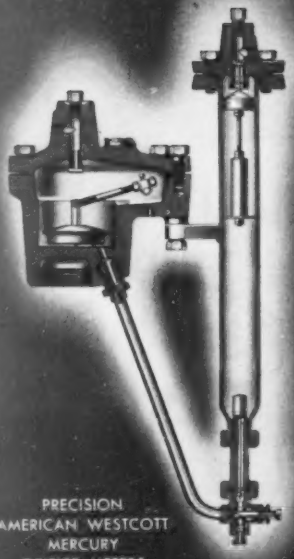
. . . outlast them all

Mack Trucks, Empire State Building, New York 1, N. Y. Factory branches and distributors in all principal cities for service and parts. In Canada: Mack Trucks of Canada, Ltd.

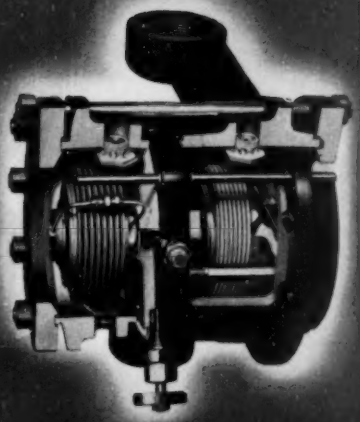
Throughout the oilfields, Mack 6-wheel trucks get the call for tough hauling jobs. Owned by Heard & Heard, Inc., Refugio, Texas, Mack Model LMSW-X is shown taking aboard a mud pump.

# AMERICAN®

## offers you TWO BASIC MEASURING INSTRUMENTS



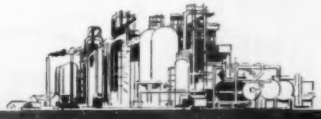
PRECISION
AMERICAN WESTCOTT
MERCURY
ORIFICE METERS

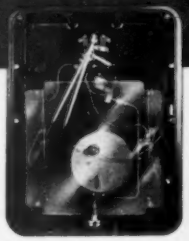


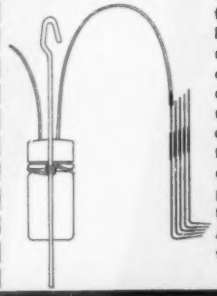
PRECISION
AMERICAN DRI-FLO
MERCURYLESS
ORIFICE METERS

Your specific requirements for differential pressure measurement will be met with one of these two field proven instruments. Both types are designed to reduce installation and operation problems. Both combine the extreme accuracy, dependability and low maintenance characteristic of all American equipment built under a long-time tradition of "Sustained Accuracy at Lower Cost."

*Write for Details*







**CANNON METER PENS**
*(Formerly Chartomatic)*
**FOR ALL TYPES OF RECORDING INSTRUMENTS**

Now, American and other types of recording instruments may be equipped with Cannon controlled-flow Meter Pens, if desired. Stainless steel pens are capillary fed by upward flow from a half-ounce reservoir holding and protecting up to a year's supply of ink. These instruments provide maximum legibility and reduce meter inking problems to the bare minimum. They are unaffected by pulsating flows, rapid pen movement, or atmospheric fluctuations and are non-clogging. Available in various styles for all standard recording instruments.

**AMERICAN METER COMPANY**
INCORPORATED ESTABLISHED 1836

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# NOW AVAILABLE

Rockwell

**LUBRICANT TUBE KEY**

Actual size of key supplied with each tube.

**GUN LUBRICANT TUBE**

Actual size of gun lubricant tube for Nordstrom valves.

**BULK LUBRICANT TUBE**

Actual size of bulk lubricant tube for Nordstrom valves.

# IN TUBES!

FOR LUBRICANT SCREW AND LUBRICANT GUN USE

## Lubricants For Nordstrom Valves

## SIMPLEST, CLEANEST, MOST ECONOMICAL METHOD OF VALVE LUBRICATION

The new Rockwell lubricant tubes were developed to provide a better means of lubricating Nordstrom valves. They are a big time and money saver for maintenance departments; a great convenience to supply stores.

For Nordstrom valves equipped with lubricant screws, you just insert tube spout in the valve shank and turn key until lubricant chamber is filled. It's easy and quick! The lubricant is always kept fresh . . . no chance for contamination by dirt or grit. The inventory problem is simplified—one tube fits all sizes and types of Nordstrom valves.

If you lubricate Nordstrom valves by lubricant gun, then specify the new Rockwell gun tube. Insert it in your gun and turn the key until all lubricant has been emptied into the barrel. The whole job takes only a few seconds.

Rockwell bulk lubricant tubes are normally packaged in boxes of four; however, single tubes are also available. Gun lubricant tubes are supplied in boxes of six.

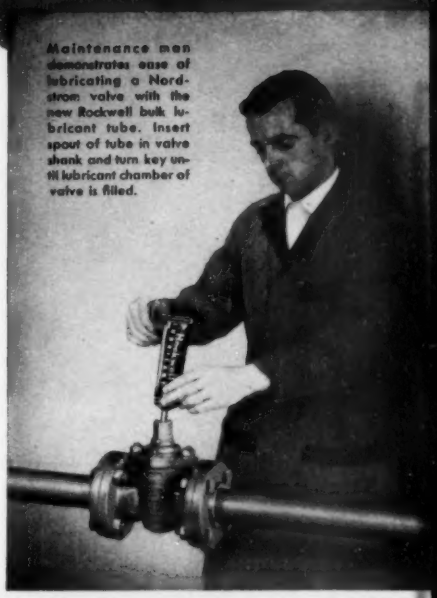
The most commonly used Rockwell Nordcoseal lubricants are now produced in tube, stick and bulk form. Other Nordcoseal lubricants and Hypermatic, the energizable lubricant, will still be available in stick and bulk form.

To assure positive valve closure, quick easy operation and longest valve life, use *only* genuine Rockwell lubricants in Nordstrom valves.

Write for bulletin V-220 describing Rockwell lubricants for Nordstrom valves. Rockwell Manufacturing Company, Pittsburgh 8, Pennsylvania.

**ROCKWELL Built**
**Nordstrom Valves**

*Lubricant-Sealed for Positive Shut-Off*



Maintenance man demonstrates ease of lubricating a Nordstrom valve with the new Rockwell bulk lubricant tube. Insert spout of tube in valve shank and turn key until lubricant chamber of valve is filled.

Demonstrating the convenience of filling a lubricant gun with the new Rockwell gun tube. Insert tube in gun and turn key until all lubricant has been emptied into the barrel.

Another ROCKWELL Product

# DOWN UNDER with RAYMOND

A Raymond-supervised organization is constructing an ocean freight terminal in Auckland, which includes a large reinforced concrete pier of earthquake-resistant design, equipped with rail, warehouse and auxiliary facilities. When completed by mid-1953, the new facilities, providing berthing space for four big ocean freighters, will increase the capacity of the port by some 550,000 tons annually . . . another outstanding example of Raymond's service to the ports of the world.

**RAYMOND** CONCRETE PILE CO.

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THE SCOPE OF RAYMOND'S ACTIVITIES . . . *FOUNDATION CONSTRUCTION* . . . *SOIL INVESTIGATIONS* . . . *IN-PLACE PIPE LINING* . . . *HARBOR AND WATERFRONT IMPROVEMENTS* . . . *SPECIALIZED CONSTRUCTION*

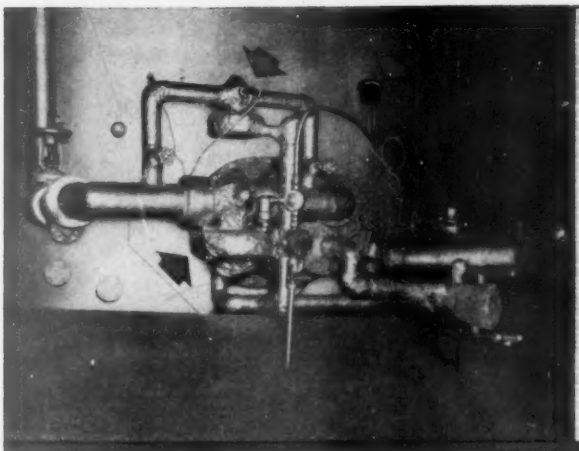


Fig. 1, Sarco type 24-30 self-contained, pilot-operated Temperature Regulators on bulk storage tanks. One of 13 installations made at Shell Oil Co., Sewaren, N. J. Remote electric pilot on main valve. Sarco float-thermostatic trap drains the heater coil.

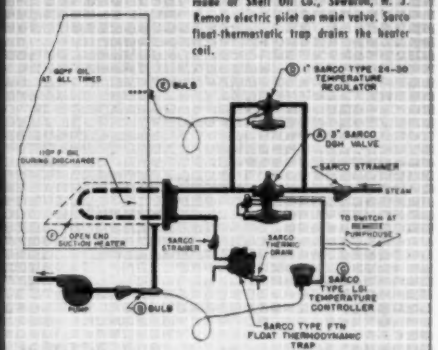
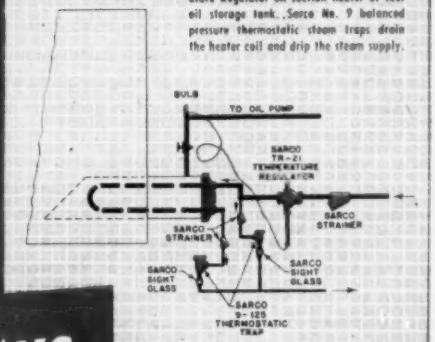


Fig. 2, Sarco TR-21 self-operated Temperature Regulator on suction heater of fuel oil storage tank. Sarco No. 9 balanced pressure thermostatic steam traps drain the heater coil and drip the steam supply.




# BULK STORAGE TANKS

● SUCTION HEATERS, as widely used to bring heavy fuel oil in bulk storage to pumping temperature, require *fast acting* temperature control. All the controlling must be done while the oil is drawn off through the heater.

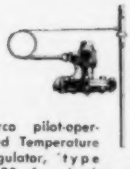
The control valve must be of the dead-end, *tight shutoff* type to prevent running away of the temperature when no oil is pumped out.

Sarco self-contained, pilot operated regulator, type 24-30, (Fig. 1) meets these requirements perfectly and will hold delivered fluid temperature constant within close limits.

Fig. 2 is a simplified hook-up for low pressure steam, using self-operated regulator, type TR-21

Send for a Questionnaire or write for Catalog 600-14, to Sarco Company, Inc., Empire State Bldg., New York 1, N. Y. Branches in principal cities. Sarco Canada Ltd., Toronto 8, Ont.

Sarco self-operated Temperature Regulator, type TR-21, sizes ½" to 8", for low pressure steam.



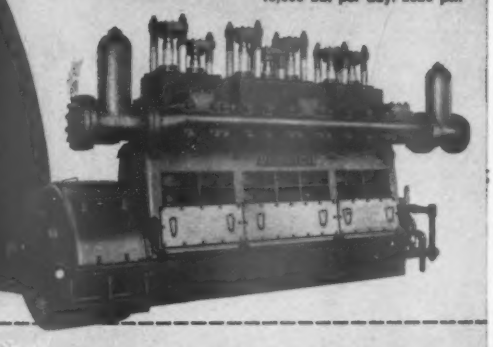
Sarco pilot-operated Temperature Regulator, type 24-30 for dead-end service and high steam pressure.

A Sarco pipeline strainer should be ahead of every regulator to keep out dirt and scale.

SARCO saves steam
improves product quality and output

**FOR THESE SERVICES:**

water flooding, salt water disposal, lean oil service, crude and gathering lines, bottom hole pump service, product lines, pumping liquids such as butane, propane, ethylene, diethylene glycol, etc.



3½" x 6" Septuplex. 250 rpm. 15,000 bbl per day. 2020 psi.

# Oil Men Select Aldrich Direct Flow Pumps because

. . . operating speeds are high. You get whatever volume and pressure you need from a smaller, lighter, more compact pump.

. . . fluid-ends are sectionalized. Parts can be replaced at low cost and can be made of stainless steel, bronze, Monel or other special materials necessary for corrosive fluid service.

. . . maintenance is simplified. No more tapered bores in the working barrel to make valve removal difficult. Now, manifolds slide out on studs and you can lift out valves as complete units. Packing is very easy to renew due to the accessibility of the stuffing boxes.

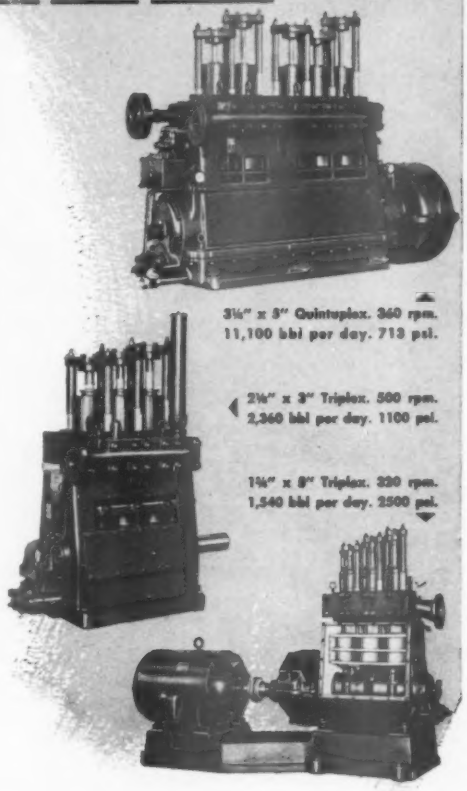
. . . plunger sizes are changeable. In many cases it is only necessary to add—besides plungers—new glands, throat bushings and packing to the same fluid-end. "Kosmos" Porcelain Plungers are standard for salt water service.

. . . wearing parts are interchangeable among 3, 5, 7 and 9 plunger pumps of the same stroke sizes. This minimizes spare parts costs and inventories.

. . . ample stocks of spare parts are maintained at Mid-Continent and California locations.

For information or catalogs, contact your nearest Aldrich representative . . . or write us direct.

*Statistics shown here are for pumps operating on actual projects. Other size pumps, other volumes and pressures are available.*



3½" x 5" Quintuplex. 360 rpm. 11,100 bbl per day. 713 psi.

2½" x 3" Triplex. 500 rpm. 2,360 bbl per day. 1100 psi.

1¼" x 8" Triplex. 220 rpm. 1,540 bbl per day. 2500 psi.

**THE ALDRICH PUMP COMPANY**

9 GORDON STREET • ALLENTOWN, PENNSYLVANIA

*...Originators of the Direct Flow Pump*

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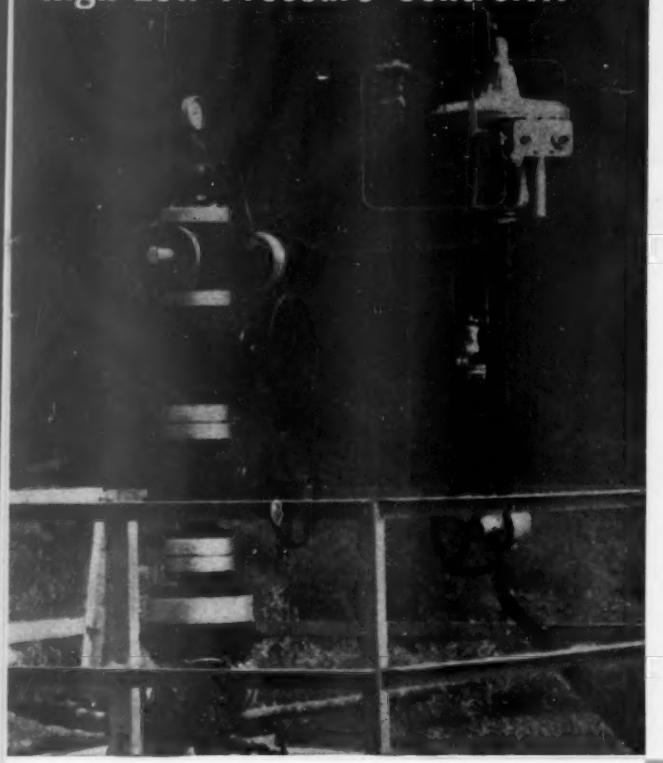
# For More Dependable, Accurate High-Low Pressure Control...



*BS&B Type 1401 High-Low Pressure Pilot on high pressure well in a Louisiana field.*

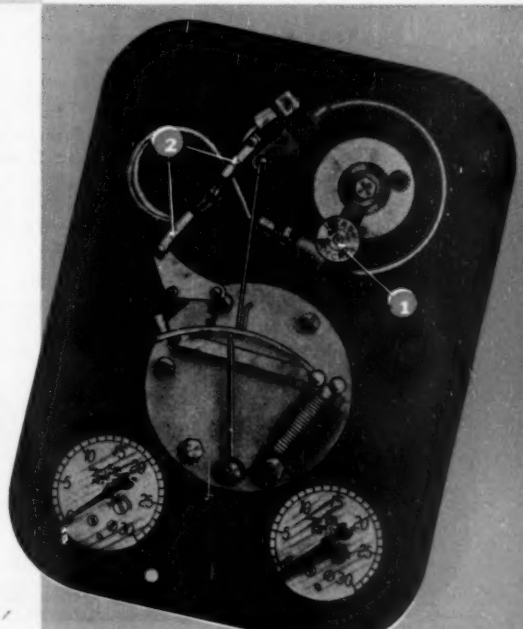
## Specify BS&B Climax • Type 1401 HIGH-LOW PRESSURE PILOT

The Type 1401 Pressure Pilot was developed to normally control reduced pressures on gas flow lines and also provide a *"Safety Shut Off"* in case of a line break. It operates as a pressure controller up to the limits of its Bourdon tube, but can also be set to close the valve at a pre-set "low pressure" for LOW PRESSURE CUT-OFF SERVICE.

**SIMPLE ADJUSTMENT • POSITIVE CONTROL** (1) The high pressure setting on the Type 1401 Pilot is obtained by means of the knob adjustment on the Bourdon tube. (2) Low pressure setting is obtained by means of a turnbuckle which locks into place. The Type 1401 High-Low Pressure Pilot can only be used with a reverse acting "AIR TO OPEN" valve.

**MANY APPLICATIONS POSSIBLE** The Type 1401 Pilot can be used for control of vacuum, reduced pressure, pump discharge pressure, maximum-minimum (on-off) control.

**FREE ENGINEERING SERVICE • NO OBLIGATION** If you have a control problem, let BS&B Climax Controls Engineers help you solve it. The Type 1401 High-Low Pressure Pilot is just one of the many controls designed, engineered and precision-built by BS&B to meet your specific needs. Write for the complete Climax catalog.



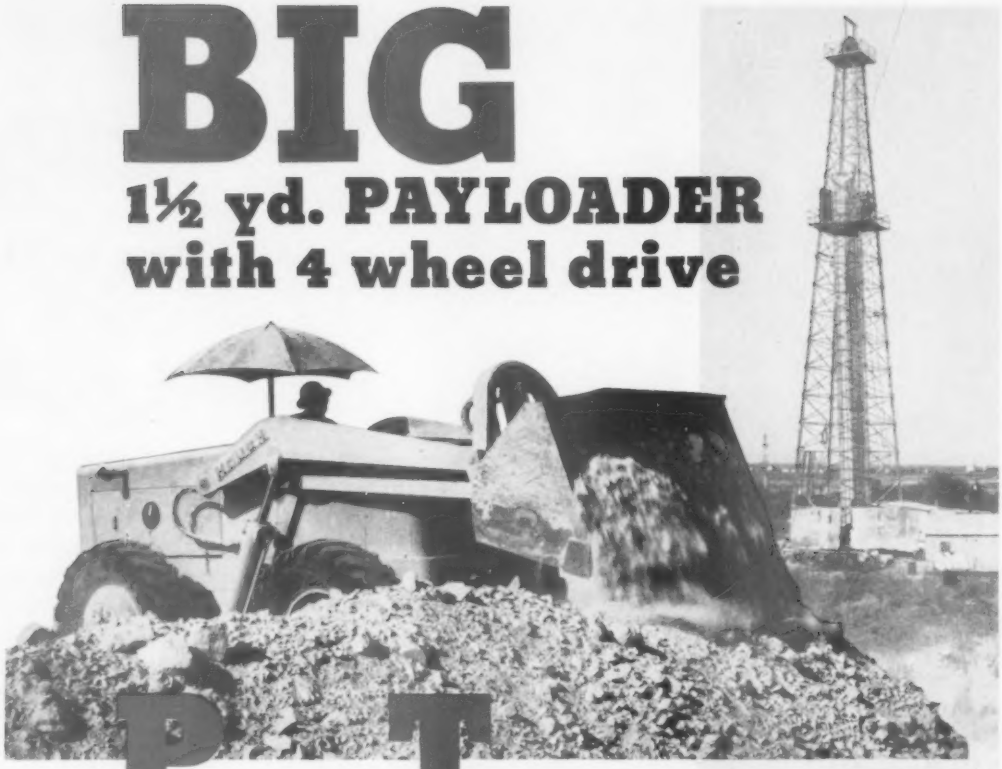

TYPE 1401

BS&B CLIMAX CONTROLS

**BLACK, SIVALLS & BRYSON, INC.**

Climax Controls Division, Dept. 4-A3
7500 East 12th Street Kansas City 3, Missouri

# BIG
## 1½ yd. PAYLOADER with 4 wheel drive



## P ower and T raction for many tasks

This unusual tractor-shovel is a powerful, versatile earth and material mover that can travel to its work over highways or fields at speeds of 20 m.p.h.—and can do many jobs when it gets there. It digs, loads, levels, backfills, spreads, lifts, lowers, pushes and pulls.

Balanced weight on all four of the big drive wheels gives tremendous traction. Four gear ratios in both directions provide the right speed for every task. Fingertip action directs the double-acting hydraulic rams for positive, precise control of the 1½ cu. yd. bucket. Power-boosted steering insures fast maneuvering in mud or loose soil without operator fatigue.

Whether your interest is in production, pipe line or refining, you should see this "PAYLOADER" in action. Your "PAYLOADER" Distributor is as near as your phone with complete sales and service facilities. The Frank G. Hough Co., 749 Sunnyside Avenue, Libertyville, Illinois.

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*dig sump pits*
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*clear rights-of-way*
*build fire walls*
*load dirt and waste*
*push, pull, lift*
*dig, level, spread*
*backfill*

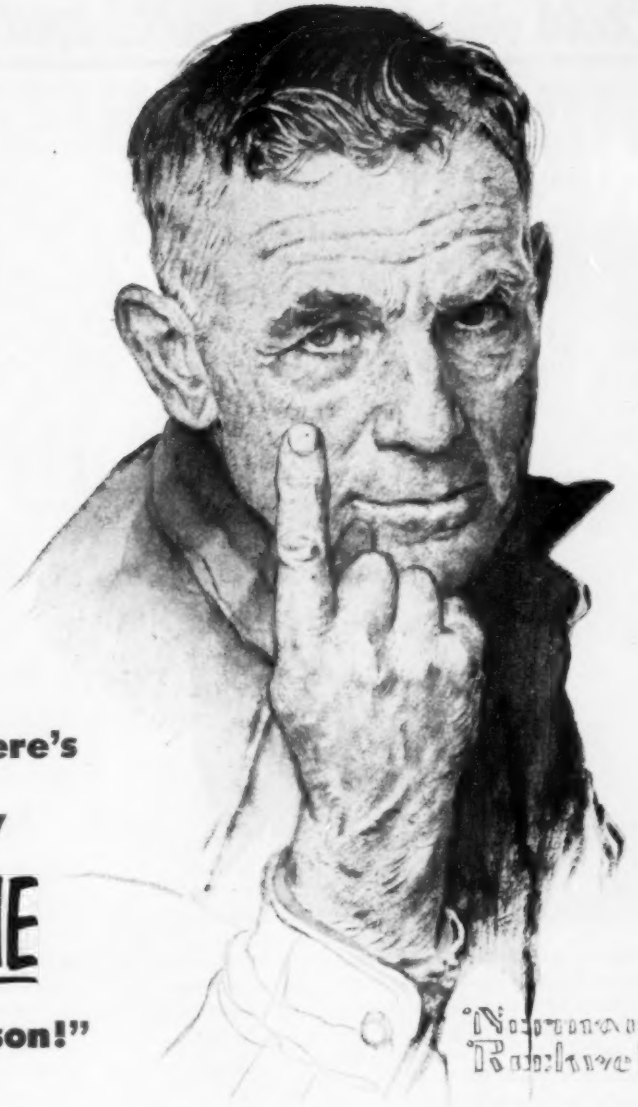
GET THE FACTS on the 4-wheel-drive "PAYLOADERS" — Models HM — 1½ yd. or HR — 1 yd.

Rear-wheel and front-wheel drive "PAYLOADERS" are also available down to 12 cu. ft. bucket capacity.

"PAYLOADER"®

SAY "HUFF"

THE FRANK G. HOUGH CO. ... MADE 1920

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For maximum wire rope efficiency and economy, call your nearest Roebling office for a Field Man. He'll recommend the best ropes for your operations... District Offices at Cleveland, Denver, Houston, Los Angeles, Odessa, Tulsa.

ROEBLING CF&I

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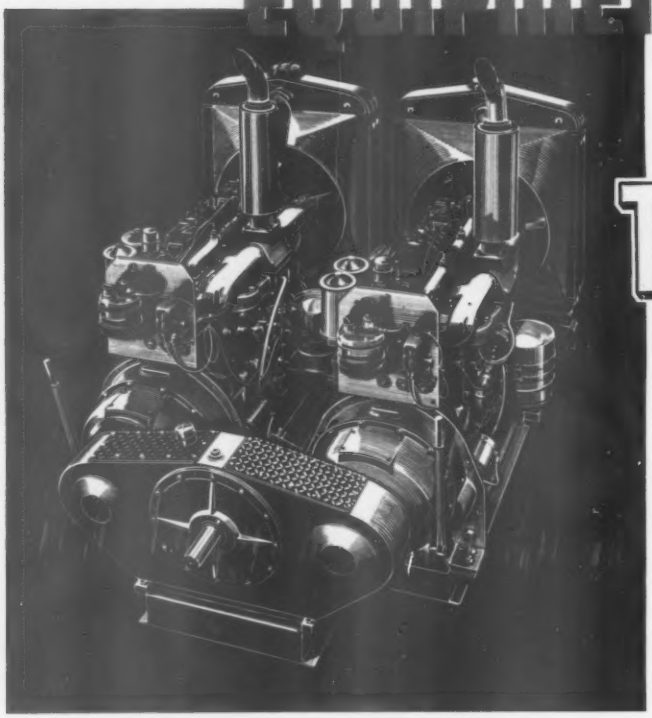
# *Oil Fields are Using More and More*

# CONTINENTAL-POWERED EQUIPMENT



CONTINENTAL MOTORS — *Powerful as the Nation's* — AMERICA'S STANDARD

## TWO RED SEALS,

**Driving Through One Shaft, Do Some Jobs Better Than the Single and Much Larger Low-Speed Engine Heretofore Used**

**ONE OF THE TRENDS of more than casual interest these days is the trend toward the use of compounded Continental Red Seal engines as a source of oil field power . . . Operators are finding that many jobs requiring power above Continental's limit—jobs for which they have heretofore had to resort to large low-speed engines of some other make—can be done to better advantage by teaming up two identical Red Seals to deliver their output through a common shaft . . . For one thing, the cost of this dual setup is comparable with, and usually less than, that of the single large unit it supplants. Horsepower for horsepower, fuel consumption is lower. The flow of power is smoother because these smaller units operate at substantially higher speeds. Finally, upkeep problems are simplified and parts costs greatly reduced . . . The wide acceptance of Red Seal engines for such compounding speaks well for the dependability which Continental has been building into specialized engines and power units for more than 50 years.**

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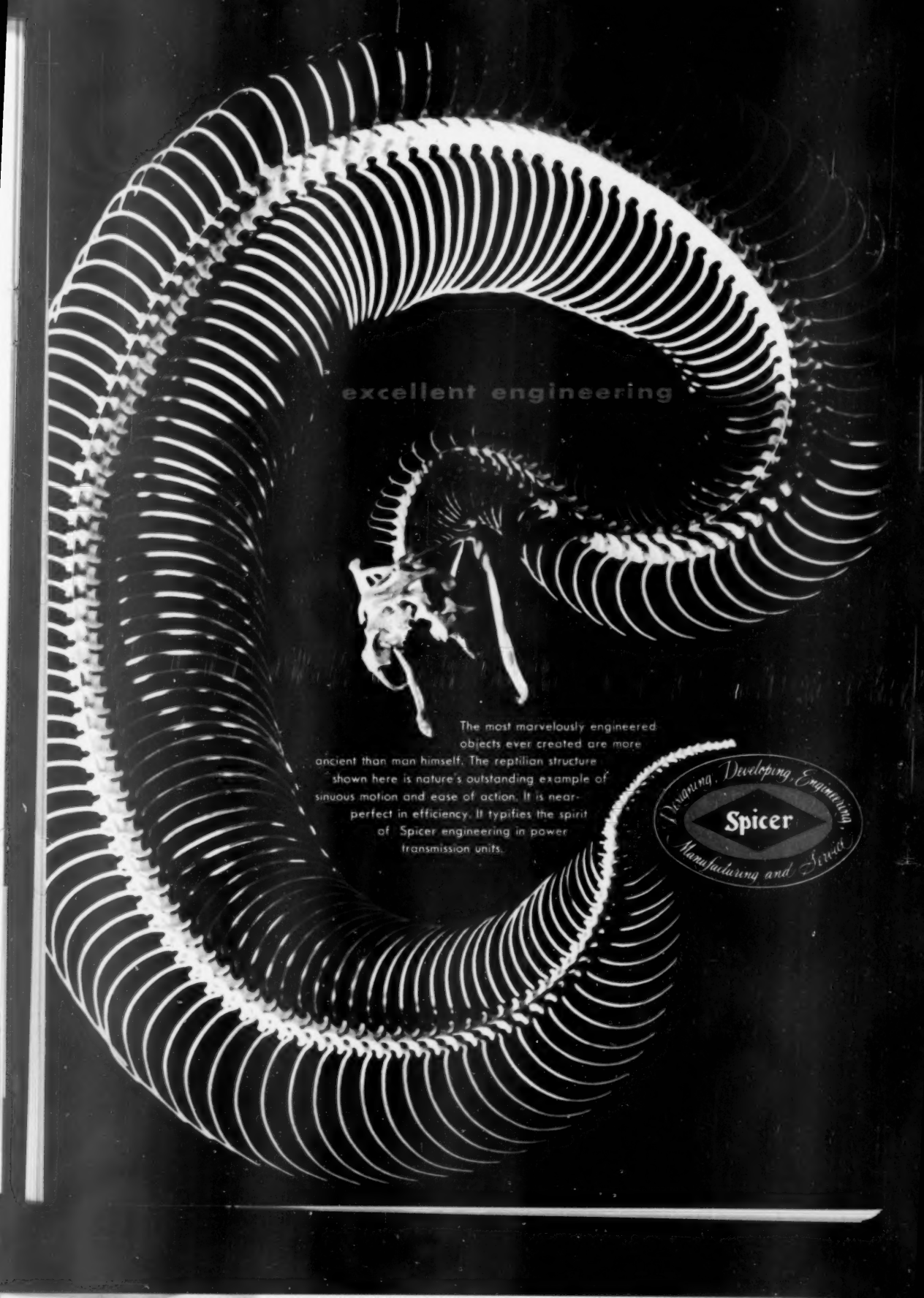
**Continental Motors Corporation**
MUSKEGON, MICHIGAN


excellent engineering
The most marvelously engineered objects ever created are more ancient than man himself. The reptilian structure shown here is nature's outstanding example of sinuous motion and ease of action. It is near-perfect in efficiency. It typifies the spirit of Spicer engineering in power transmission units.
Designing, Developing, Engineering
Spicer
Manufacturing and Service

# engineered for excellence

The Spicer *Fully-Synchronized* Transmission is man's outstanding example of efficiency in transferring automotive power. It is silk-smooth in action. Remarkably simple and sure in control. It's the driver's dream in heavy-duty truck and bus operation . . . the equipment owner's ideal in economical service. Since 1908 the Spicer Fully-Synchronized Transmission has been the

*Standard of the Industry*

**SPICER MANUFACTURING DIVISION** *of Dana Corporation*
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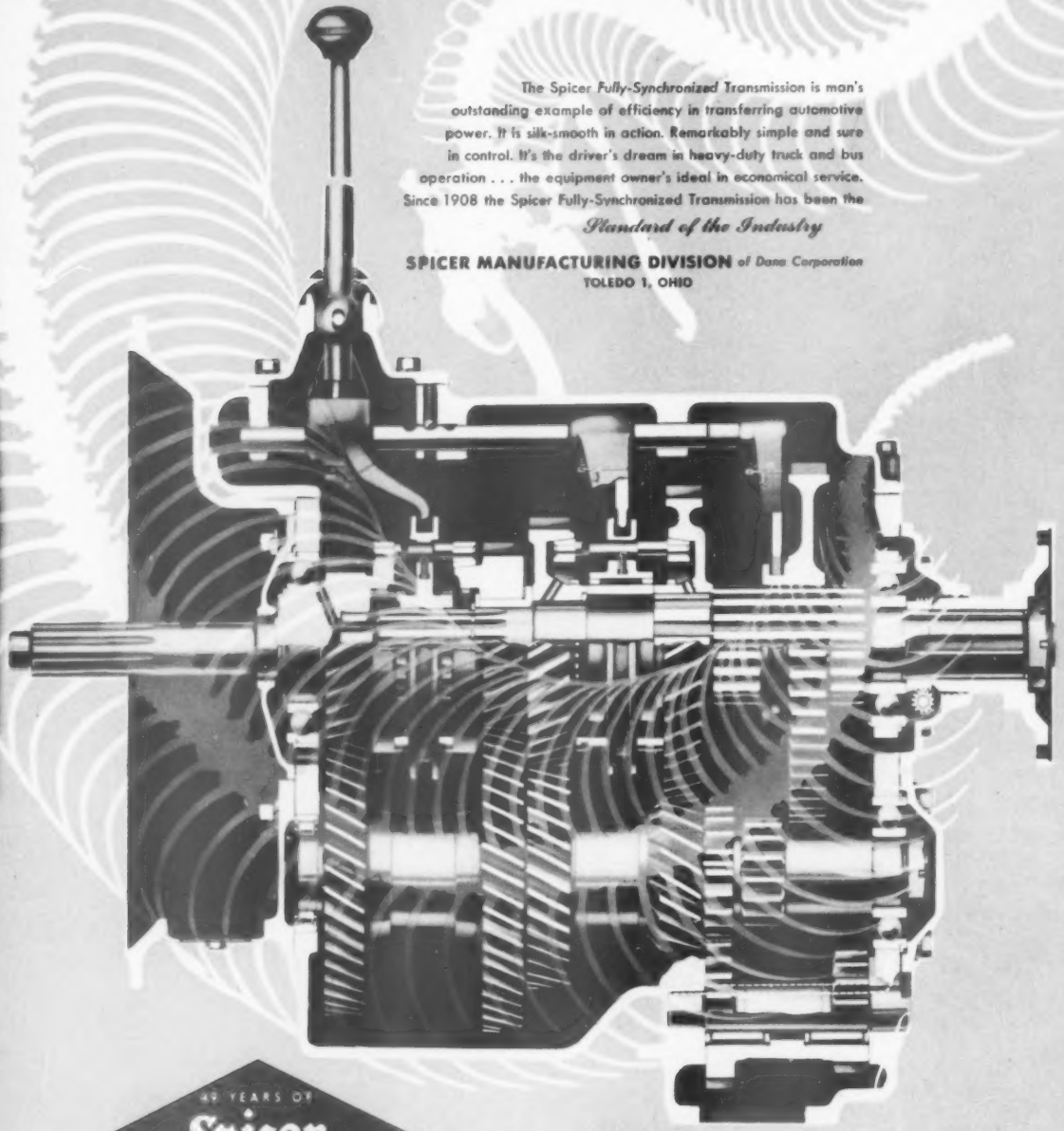

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*We endorse the Junior Achievement Program*

B&W BULLETIN 6-F

# Properties of Carbon, Alloy and Stainless Steel Tubing for High-Temperature and High-Pressure Service

## The Story of the Croloys

**New data contained in the seventh, revised edition of B&W's Technical Bulletin 6-F make it must reading for technical personnel concerned with the properties of tubing for high-temperature and high-pressure service. TB-6F contains up-to-the-minute information on:**

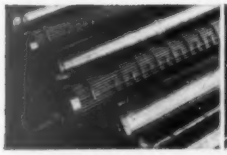
- Requirements of Tubing for High-Temperature Service
- Influence of Alloying Elements
- Chemical Composition
- Room-Temperature Properties
- Short-Time Tensile Properties
- Stress-Rupture
- Creep
- Thermal Expansion
- Thermal Conductivity
- Impact Properties
- Microstructure—Transformation Temperatures
- Air-Hardening Properties
- Effect of Hydrogen
- Common Causes of Tube Failures
- Upset, Formed and Machined Tube-Ends

On such grades as

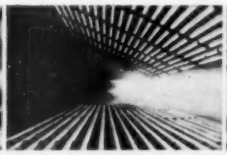
| B&W | NOMINAL ALLOY CONTENT | MAXIMUM SERVICE TEMPERATURE |
|---|---|---|
| Carbon Steel (Killed) | | |
| Carbon-Moly | 0.50% Mo | 1050F |
| Croloy ½ | 0.60% Cr<br>0.50% Mo | 1075F |
| Croloy 1 | 1% Cr<br>½% Mo | 1150F |
| Croloy 1¼ | 1.25% Cr<br>0.50% Mo | 1100F |
| Croloy 2 | 2% Cr<br>0.50% Mo | 1150F |
| Croloy 2¼ | 2.25% Cr<br>1.00% Mo | 1175F |
| Croloy 3-M | 3% Cr<br>0.90% Mo | 1175F |

| B&W | NOMINAL ALLOY CONTENT | MAXIMUM SERVICE TEMPERATURE |
|---|---|---|
| Croloy 5 | 5% Cr<br>0.50% Mo | 1200F |
| Croloy 5-Si | 5% Cr<br>0.50% Mo<br>1.50% Si | 1300F |
| Croloy 7 | 7% Cr<br>0.50% Mo | 1250F |
| Croloy 9-M | 9% Cr<br>1% Mo | 1300F |
| Croloy 16-13-3 | 16% Cr<br>13% Ni<br>3% Mo | 1600F |
| Croloy 18-8 | 18% Cr<br>8% Ni | 1600F |
| Croloy 25-20 | 25% Cr<br>20% Ni | 2100F |

Write for your copy —on company letterhead, please.



Chemical



Oil

Power

TA-1739 (P)

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**TUBULAR PRODUCTS DIVISION**
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Alliance, Ohio—Welded Carbon Steel Tubing

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*for new tanks or the modernization of old*

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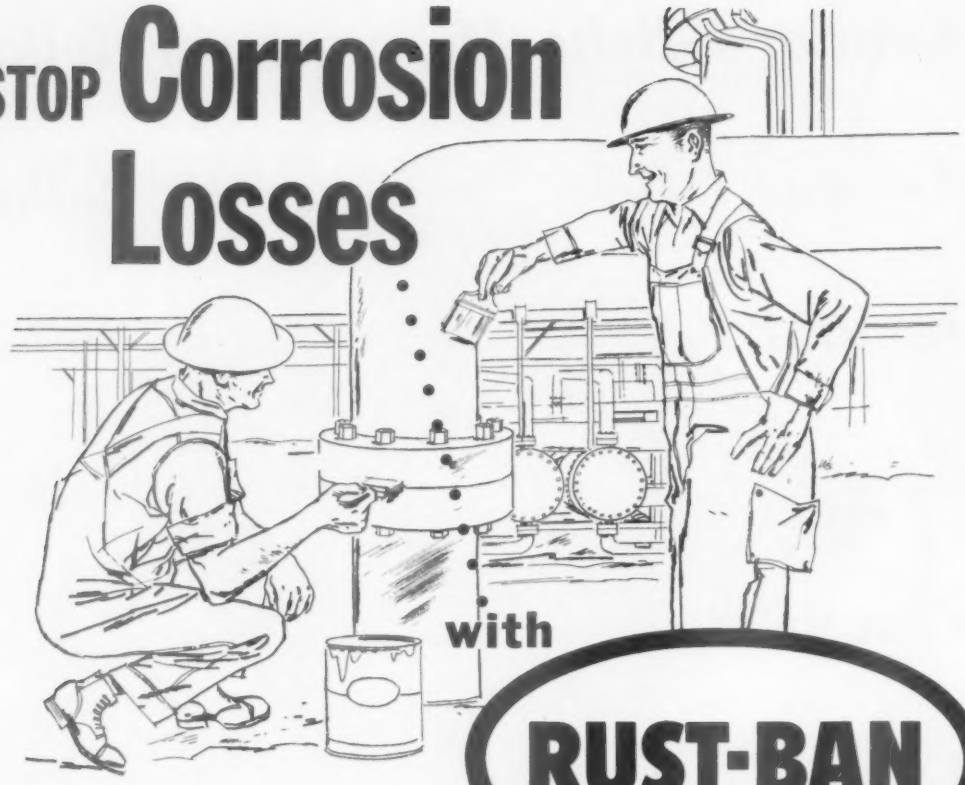

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Rust-Ban is not a single product. It is a complete line of protective coatings designed for every condition requiring protection against corrosion. Special Rust-Bans are available for such difficult exposures as in oil refineries, chemical plants, ice plants, the marine industry and others.

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Midwest Reducing Elbow replaces two fittings (1) a straight size elbow and (2) a reducer. One weld is eliminated with a resultant saving in layout time, welding, and cost. Pressure drop is reduced, appearance is improved and the piping is easier to insulate. Sizes to 12", reductions to half size.

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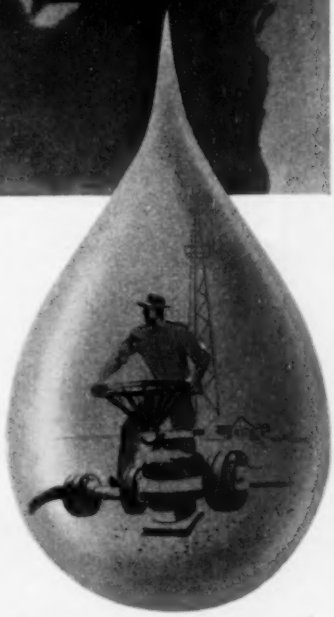
For almost any type of fabricated structural steel and platework —used in refinery or field operations, remember the name: DOMINION BRIDGE.



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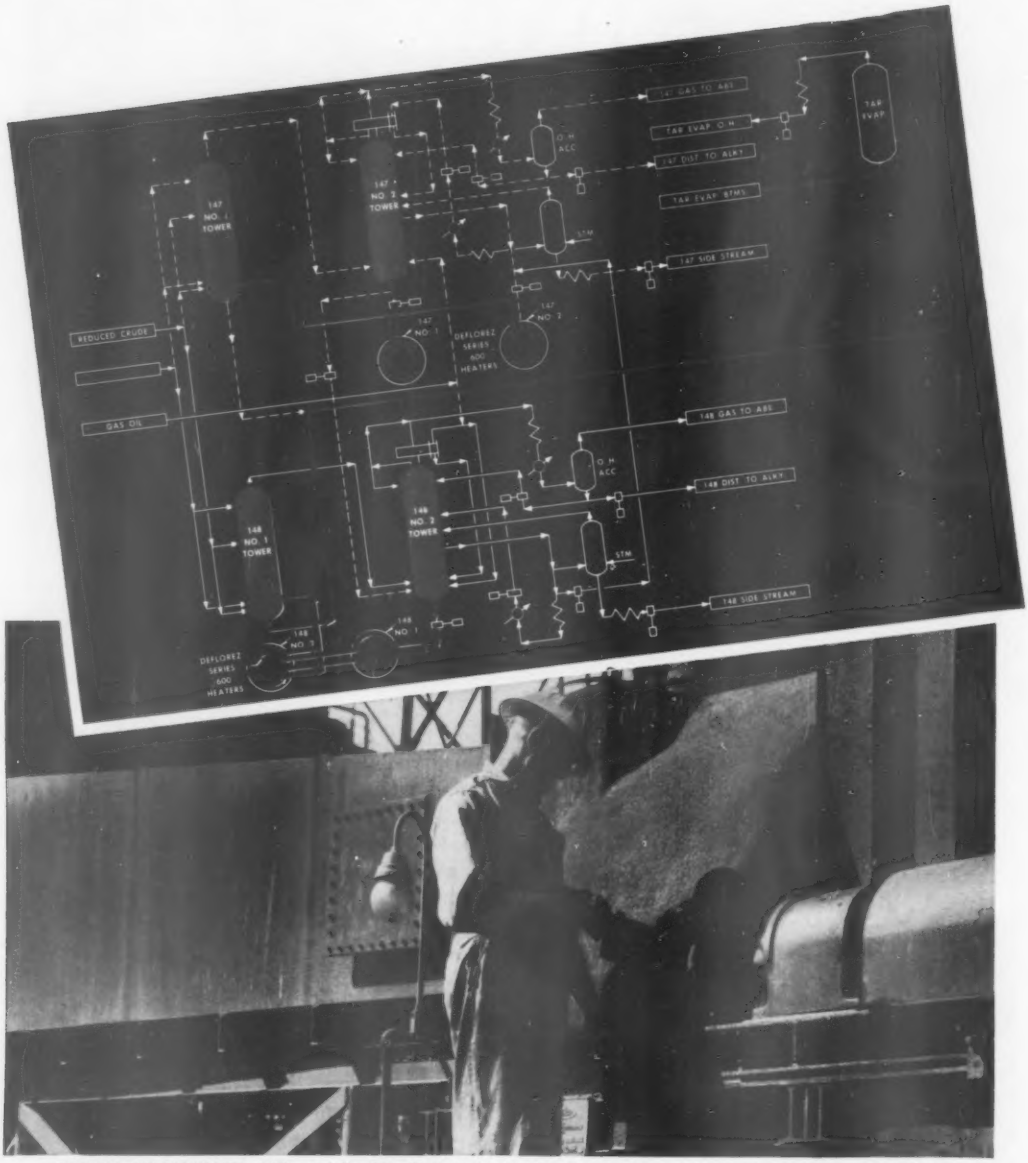
# How SINCLAIR REFINING COMPANY




**CIRCULAR AIR PRE-HEATER** of Thermal Cracking Unit at this Sinclair Refining Company operation has elements of 11-12% chromium Stainless with U·S·S 18-8 used in certain high temperature areas.

# uses *Stainless Steel*

## in this Thermal Cracking Unit at Houston Refinery

Operating on a 100% high sulphur charging stock and processing 4500 barrels of gasoline daily, this Thermal Cracking Unit at Sinclair Refining Company's Houston Refinery, Houston, Tex., depends heavily on Stainless Steel to keep production flowing and downtime at a minimum.

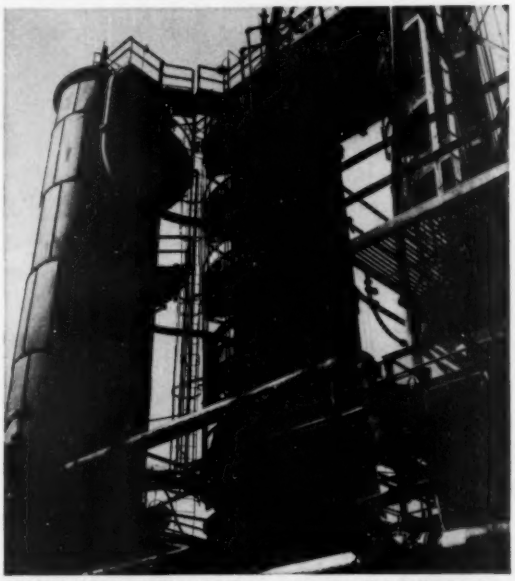
The flow diagram shown here indicates the extensive use of Stainless. Red lines on the diagram indicate where it is used.

Heater tubes in the furnaces are Stainless Steel —4-6% chromium in areas where temperature does not exceed 850°F.; 7-9% chromium in areas where it does exceed 850°F. The circular air preheater has 11-13% chromium elements with U·S·S 18-8 Stainless in areas where flue gas enters at 1300°F. and leaves at 550°F.

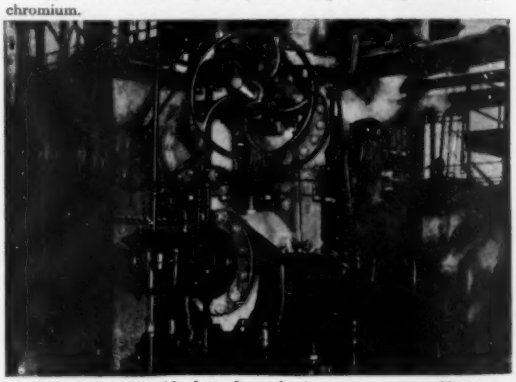
The fractionating towers are lined with 11-13% chromium Stainless Steel and internals, including bubble caps and trays, are 7-9% chromium. Transfer lines between furnaces and fractionating towers, operating under 600 psi pressure at 965°F. are 7-9% chromium Stainless Steel.

Made entirely from Stainless Steel is a pump that handles residual tar from tar evaporator units.

There are many locations in your plant where the proper grade of Stainless Steel can help you maintain uninterrupted production. Our metallurgical and research personnel will be glad to assist you with recommendations. There is no obligation, of course.



**FRACTIONATING TOWER** in the Thermal Cracking Unit is lined with 11-13% chromium Stainless Steel; bubble caps and trays are 7-9% chromium.



**PUMP HANDLING** residual tar from the tar evaporator at Houston Refinery is Stainless Steel throughout.

UNITED STATES STEEL CORPORATION, PITTSBURGH · AMERICAN STEEL & WIRE DIVISION, CLEVELAND · COLUMBIA-GENEVA STEEL DIVISION, SAN FRANCISCO
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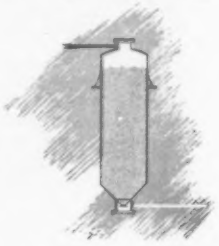

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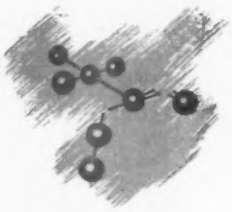

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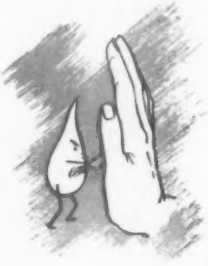

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Dept. V, 210 West Washington Square, Philadelphia 5, Pa.

# Make your next oil field truck a heavy-duty FWD..

This FWD 6 x 6 Model MU, with integral derrick, lifts pipe out for cleaning and servicing, lowers it back when job is done.

Here is an FWD U series tractor loading drilling mud mixed with crude oil for access road surfacing. It also hauls heavy pipe and drilling equipment.

In the Michigan fields, this FWD is used to move six drilling rigs from well to well.

This FWD 6 x 6 provides high speed transport for heavy equipment and machinery despite frequent poor footing.

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Whether you're about to replace some of your older trucks or looking for a rugged trouble-shooter, an FWD is the answer. That's because FWDs for oilfields, pipelining and exploration give you all the advantages of true four-wheel-drive traction PLUS low maintenance.

Designed with the help of veteran oil men FWDs have *"built-in"* features that oilmen want. As a result, FWDs haul bigger loads, get through where other rigs fail, work more days per year, yet cut your service and maintenance bills.

To get the details, see your FWD dealer. He'll be pleased to help you select the FWD 4 x 4 or 6 x 6 model or models that meet your exact needs.

THE FOUR WHEEL DRIVE AUTO CO.
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An FWD 6 x 6 starts to lift pipe out of a well in the West Edmund field north of Oklahoma City. It has a portable derrick for servicing wells without a permanent derrick.

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There has been what might be called a chemistry of progress at work in Sun Ship's mighty plant to match the progress of chemistry. The services of its great shops, the skills of its thousands of workers, have been adapted like atoms into new patterns which enable the great plant to make and fabricate the array of equipment . . . the engines and machinery . . . pressure vessels . . . fractionating towers . . . stills . . . tanks . . . catalytic cracking cases and other equipment which serve modern chemistry in building a greater America.

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It is one of the most efficient, fast-acting, fire extinguishing units which Alfco engineers have yet devised. Containing 350 lbs. of Alfco Dry Chemical, the smothering action of its deadly discharge on fire is sensational.

Blistering hot fires of considerable proportions which at first may appear too monstrous for control, can be quickly extinguished.

Its discharge pattern is fan shaped. The density of the dispersion of the Dry Chemical is total! Effective range is 20 to 25 ft. Expelling agent is *dry* nitrogen. Discharge time is about 1 min., 15 sec. Dry Chemical is nontoxic, noncorrosive, a nonconductor of electricity and will not freeze.

Approved by Underwriters and Factory Mutual Laboratories. Rating B. C.

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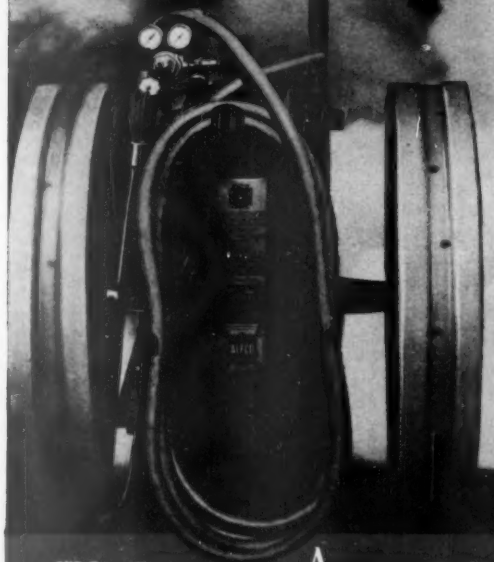

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OUR *2nd Century of Leadership in* FIRE PROTECTION

AMERICAN-LAFRANCE-FOAMITE *Corporation*

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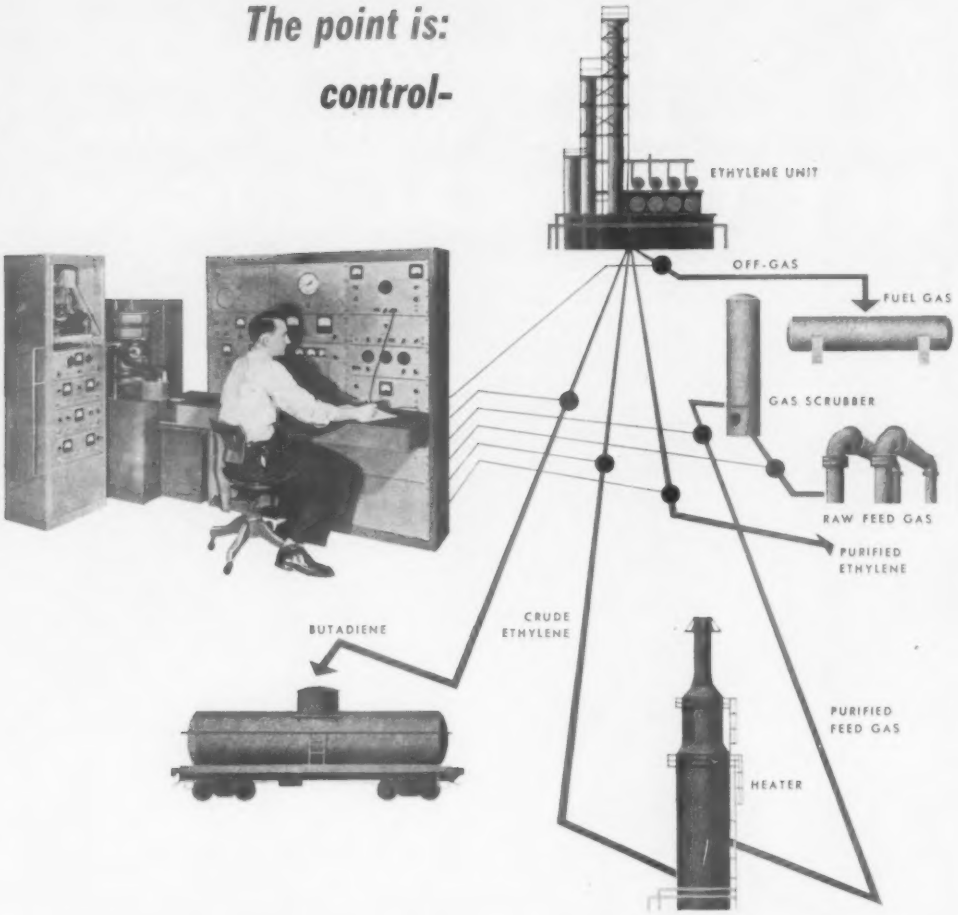
## The point is: control-

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**The Consolidated Analytical Mass Spectrometer shown above is used extensively by leading refineries throughout the world for analytical research as well as process control. For complete information on this instrument, write for Bulletin CEC 1800-X9**

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actually require
less maintenance
First, because they are specifically adapted to the service conditions under which they must operate.
Second, because they are engineered—in design, materials, and workmanship—to stand up under those service conditions.
And the proof lies in the actual records of the thousands of Powell Valves that are serving all branches of industry.
The Wm. Powell Company
Cincinnati 22, Ohio
DEPENDABLE VALVES
SINCE 1846
POWELL

Here's what the Posey Iron Works offers to assure oil men of safety and soundness in pressure tanks:

1. A practical, workaday knowledge of peak loads . . . pressure . . . reserve capacities . . . fire protection requirements . . . steels . . . alloys . . . and specialized construction as they relate to the oil field.

2. Advanced inspection techniques that reveal flaws *prior* to shipment. These techniques include x-ray . . . hydrostatic . . . and hammer tests. Tanks are tested to a considerable excess over working pressures.

3. In welding Posey Iron tanks, only modern equipment and qualified welders are used. Edges of plates are always properly prepared. That's why tests unvaryingly show a high degree of joint efficiency in vessels built by Posey Iron.

4. Posey Iron construction fully meets the ASME code for unfired pressure vessels. Products are designed and built to comply with the requirements of the ASME; API-ASME; API and other codes. The Posey Iron Works is authorized to apply the appropriate code symbols.

"Play safe" — ask Posey to bid on your pressure vessels.

Alloy steel pipe fabricated by the Posey Iron Works for refinery use

Fractionating column (awaiting shipment) for high octane aviation gasoline — 3' I.D. x 133' high

POSEY IRON WORKS, INC.

*Steel Plate Division*

LANCASTER, PA.

New York Office: Graybar Building

ESTABLISHED SINCE 1910

DIVISIONS
Brick Machinery
Foundry
Industrial Heating
Pressure
Shipbuilding
Steel Plate

# New wonder metal to wearproof

SPRAY NOZZLES

CHECK VALVES

ORIFICES

**OTHER SUGGESTED APPLICATIONS**

- Sheer blades for molten glass
- Core pins for ceramic baking
- Fishing rod guides
- Centrifuge nozzles, separating equipment
- Bearings where corrosives are present
- Textile guides, and many other parts where corrosion with abrasion and erosion must be resisted

# Carboloy Chrome Carbide protects parts, fights corrosion, abrasion, erosion

## CORROSION TESTS

**Grade 608 Chrome Carbide—Other Cemented Carbides—Stainless Steel**

**LOSS IN WEIGHT IN MILLIGRAMS PER SQUARE DECIMETER PER DAY AVERAGE OF 10—24 HOUR IMMERSION PERIODS**

| Test | Chemical Used | RESULTS | | | | |
|---|---|---|---|---|---|---|
| | | Series 600 Chrome Carbides | Other Cemented Carbides | | | 18-8 Stainless Steel |
| | | | WC + Co | WC + TaC + TiC + Co | WC + TaC + Co | |
| 1 | 10% $H_2SO_4$ (10% Sulphuric Acid) | 55 | 158 | 302 | 135 | 1650 |
| 2 | 50% $H_2SO_4$ (50% Sulphuric Acid) | 31 | 100 | 120 | 81 | 7300 |
| 3 | 37% HCl (37% Hydrochloric Acid) | 190 | 600 | 650 | 160 | Total Loss |
| 4 | 35% HNO (35% Nitric Acid) | 19 | 250 | 330 | 110 | 45 |
| 5 | $HNO_3$—HCl (Aqua Regia) | 810 | 2820 | 4500 | 1550 | Total Loss |
| 6 | NaBCl .07 $Cl_2$ PH 9 (Sodium Hypochloride) | 100 | 230 | 1000 | 158 | 11 |
| 7 | 5% NaOH (5% Sodium Hydroxide) | 0.6 | 22 | 7 | 12 | 1.0 |
| 8 | 50% NaOH (50% Solium Hydroxide) | 1.0 | 3 | 3 | 4 | 2.0 |
| 9 | 5% $CaCl_2$ (5% Calcium Chloride) | 0.3 | 41 | 24 | 27 | 1.3 |
| 10 | 1.0% Citric Acid | 0.6 | 176 | 150 | 160 | 2.0 |
| 11 | 5.0% Lactic Acid | 1.5 | 200 | 170 | 255 | 5.1 |

Acids, alkalis, heat, oxidation, erosion, abrasion cutting down the life of your equipment parts?

Then here's a brand new Carboloy created-metal worth checking into. It's Grade 608 Chrome Carbide – not a cutting metal, but the first member of an entirely new family of metallic carbides especially for wearproofing . . . outstandingly effective in resisting corrosion and erosion combined with abrasion.

In addition, chrome carbide is lightweight, non-magnetic, stable, strong, machineable . . . has a coefficient of thermal expansion similar to that of steel. Chemical test results, left, for example, show how chrome carbide stands up under acids. For full details on physical properties, characteristics, application histories, etc., of this new created-metal, send coupon for free Chrome Carbide data sheets.

## USE TUNGSTEN CARBIDE WHERE ABRASION IS THE PRIME FACTOR

Carboloy Tungsten Carbide is currently doing an excellent percussion wearproofing job in seismographic drilling. Its exceptional resistance to abrasion is the prime factor; it greatly increases product life and performance in such applications as tri-cone rotary bits, flow beans, gas lift valves in oil and gas separators, and in many other parts. Send coupon for free data on these Carboloy Tungsten Carbide advances, too.

"Carboloy" is the registered trademark for the products of Carboloy Department of General Electric Company

**CARBOLOY**

**DEPARTMENT OF GENERAL ELECTRIC COMPANY**

**11181 E. 8 Mile Road, Detroit 32, Michigan**

PLANTS AT DETROIT, MICHIGAN; EDMORE, MICHIGAN; AND SCHENECTADY, NEW YORK

**MAIL COUPON TODAY FOR FREE CHROME CARBIDE DATA SHEETS**

**CARBOLOY Department of General Electric Company**
**11181 E. 8 Mile Road, Detroit 32, Michigan**

☐ Please rush me free Technical Bulletin WR-104 containing Chrome Carbide Data Sheets. ☐ Also, details on Tungsten Carbide oil-field applications.

Name _____ Title _____

Company _____

Address _____

City _____ Zone ____ State _____

**APPLYING** "Scotchrap" Pipe Insulation is a quick, easy job—requires no special equipment.

# "Scotchrap" cuts coating costs in half!

*Remarkable savings reported on installation of gas line at Glen Lake, Minn.*

Six hundred feet of buried gas line protected against corrosion for less than half the usual costs! That's the story from John L. Hanson, Secretary of Bjorkman Brothers Co., Minneapolis, contractors for the job at Glen Lake Sanatorium. And "Scotchrap" Pipe Insulation made those savings possible.

"Scotchrap" is a tough plastic tape with a pressure-sensitive adhesive that sticks to the job right off the roll.

That means no special applicating equipment is necessary—although "Scotchrap" can be machine wound if you prefer. It means faster "on the spot" coating without the danger of scalds and burns from usual methods.

And "Scotchrap" lasts and *lasts.* Plastic backing resists acids, alkalies, alcohols, water, oils, fungus, bacteria—even galvanic and electrolytic action.

Try it *yourself* and see. Order a supply today!

John L. Hanson, Secretary
Bjorkman Brothers Co.,
Minneapolis, Minn.

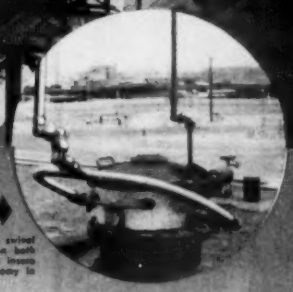
**SCOTCHRAP**
BRAND
**PIPE INSULATION**

The term "Scotch" and the plaid design are registered trademarks for the more than 200 pressure-sensitive adhesive tapes made in U. S. A. by **Minnesota Mining & Mfg. Co., St. Paul 6, Minn.** — also makers of "Scotch" Sound Recording Tape, "Underseal" Rubberized Coating, "Scotchlite" Reflective Sheeting, "Safety-Walk" Non-slip Surfacing, "3M" Abrasives, "3M" Adhesives. General Export 122 E. 42nd St., New York 17, N. Y. In Canada: London, Ont., Can.

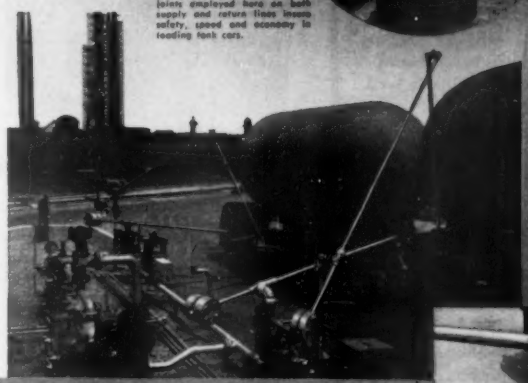
# When Butane says "HANDLE WITH CARE"

# CHIKSAN ADDS SAFETY and SPEED TO LOADING OF TANK CAR AND TRUCK

With counterbalanced Chiksan loading racks, one man can quickly and easily make connections to tank cars.



CHIKSAN low pressure swivel joints employed here on both supply and return lines insure safety, speed and economy in loading tank cars.



A typical near ground level truck loading rack using CHIKSAN joints on supply and return lines.

Close up of CHIKSAN low pressure joints on supply and return lines in truck loading of Butane.

It takes speed, safety and kid-glove handling to keep up the massive flow of liquefied petroleum gas at Standard Oil Company of California's El Segundo plant.

Chiksan provides the necessary liquid-tight, gas-tight unions, the characteristic flexibility of motion to keep the touchy Butane flowing at a swift, even pace with safety to workers, plant and community — with profit to the company.

No less than eight Chiksan Ball-Bearing Swivel Joints are needed for each loading installation to keep the gas moving into tank and truck—to provide the essential carry-off of the highly explosive vapors. And with Chiksan on the job, metal of relative low porosity takes the place of more porous and less safe rubber.

Standard Oil Company of California's El Segundo installations are typical of industry's reliance on Chiksan Ball-Bearing Swivel Joints around the world to speed the flow of enterprise — to promote production and defense—to increase safety—to protect profits.

*Wherever liquid or gas must flow in industry — wherever hydraulic systems can add efficiency and economy—Chiksan Ball-Bearing Swivel Joints are on the job. If more flexibility—greater stamina—longer life and added economy are of interest to you, Chiksan's Research and Development Division can help you find a better, swifter way.*

*The Flow of Enterprise Relies on* **CHIKSAN** *Ball-Bearing Swivel Joints*

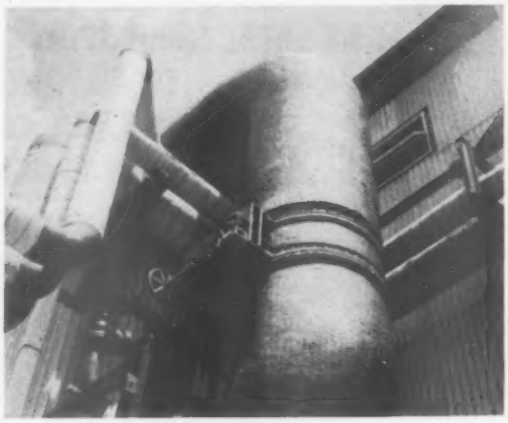
Representatives in Principal Cities  Write for Catalog 53-C. Dept. 003-3

**CHIKSAN COMPANY • BREA, CALIFORNIA • Chicago 28, Illinois • Newark 2, New Jersey**

Well Equipment Mfg. Corp. (Division), Houston 1, Texas • Chiksan Export Company (Subsidiary), Brea, California, Houston 2, Tex. U.S.A.

R-S valvEvents

• EXCERPTS FROM THE R-S BOOK OF EXPERIENCE •



# R-S VALVES
## OPERATE EASILY
### *Above or Below Floor Level*

Because of their comparative light weight and minimum space requirements, R-S Valves are particularly well adapted for installation at considerable heights above the floor level. In such positions they are usually operated manually by chainlever, chainwheel, extended reach rod or controlled automatically.

Where the valve must be installed in an inaccessible position below the floor level, a floor stand is provided. Control is just as quick and uniform as in those installations where the handwheel is mounted directly on the valve shaft.

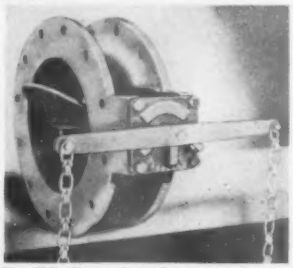
Simplicity of design, the wide range of application and ease of operation indicate the high order of metallurgical and mechanical engineering that is embodied in every R-S Valve.

*Consult your local R-S Valve Engineers, or write direct.*

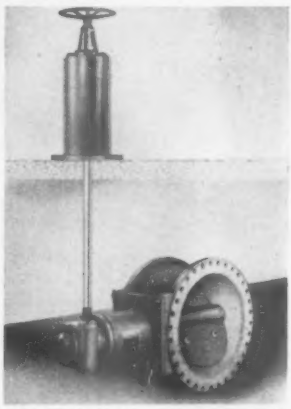
**R-S PRODUCTS CORPORATION**
**4600 Germantown Avenue, Philadelphia 44, Pa.**

*An S. Morgan Smith Company Subsidiary*

**DISTRICT OFFICES IN PRINCIPAL CITIES**



**No. 688—Heavy duty chainlever valve for quick opening or closing in elevated and inaccessible locations. R-S Valves are used to control and shut-off the volume and pressure of nearly all materials in the temperature range from minus 300° to plus 2000° F. 2 to 2500 psig.**

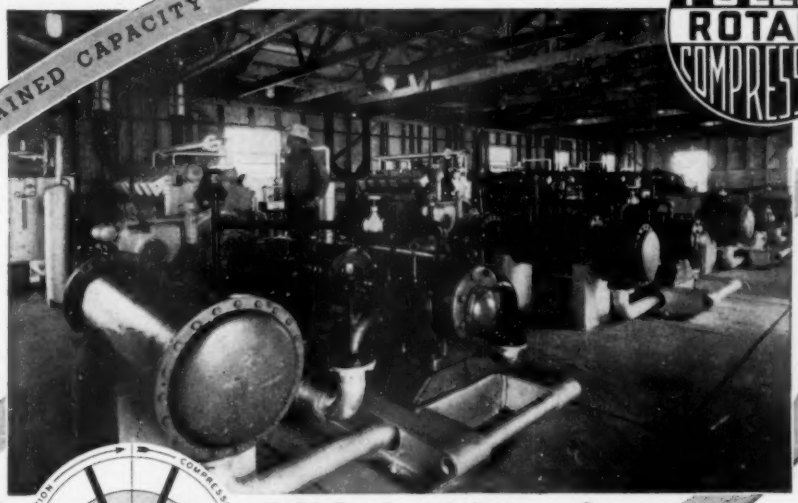


**No. 788—Heavy duty valve equipped with rubber seat, totally enclosed gear reduction drive, extended shaft and floor stand. Positive shut-off is obtained up to 125 psig with rubber seated valves and commercially tight shut-off to even higher pressures with a babbitted seat.**

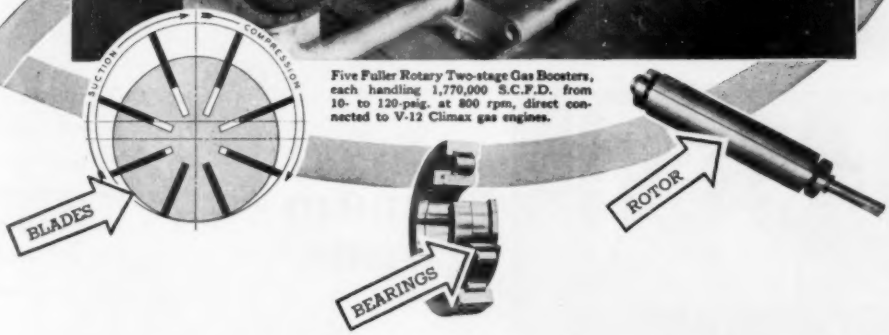
**No. 839—8-inch heavy duty valve equipped with 125-pound flanges, 18-8 shafts, bronze bushings and a throttling type motor operator for the control of low pressure air.**

MAINTAINED CAPACITY FOR THE LIFE OF THE MACHINE

FULLER ROTARY COMPRESSORS



Five Fuller Rotary Two-stage Gas Boosters, each handling 1,770,000 S.C.F.D. from 10- to 120-psig. at 800 rpm, direct connected to V-12 Climax gas engines.



Due to design and construction, the blades of a Fuller Rotary Compressor automatically compensate for wear, thus eliminating loss of capacity. *Maintained capacity* is just one of the many outstanding features of the Fuller Rotary.

The fewer moving parts that make up any piece of equipment, the more continuous service at the lowest operating cost. Fuller Rotary Compressors are an outstanding example of simplicity . . . few moving parts—rotor, bearings, blades.

There is no adjustment of valves, no grinding of seats, no bearing take-up . . . moving parts are reduced to the minimum, all of which means fewer shut-downs, with less costly maintenance charges. Shut-downs are costly . . . lost time can never be recovered. Install Fuller Rotaries for day in and day out, continuous service.

Fullers are built for capacities to 3300 c.f.m. actual free-air delivery, 125-lb. pressure. Write for Bulletin C-6, illustrating and describing the design and construction of this modern compressor.

**FULLER COMPANY, Catasauqua, Penna.**

*Branch Offices*

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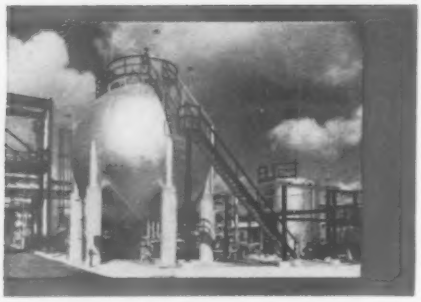
C-234
2077

**Fuller**

PIONEERS OF HIGH-EFFICIENCY VANE-TYPE ROTARY COMPRESSORS

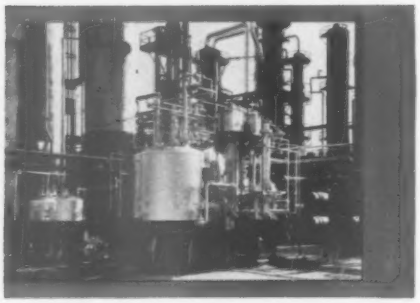
# FOR MORE PROFITABLE REFINING

## PETRECO
### ELECTRIC PROCESSING



**DESALTING**

Petreco Electric Desalting eliminates salts, solids, and other impurities with such a high degree of efficiency that salt difficulties are eliminated — enabling refiners to run more crude.



**DISTILLATE TREATING**

Petreco Electric Distillate Treating takes the guesswork out of distillate treating. It is applicable to acid, alkali or doctor treating all distillate stocks. It permits continuous, automatically controlled treating with minimum equipment, handling and attention.

**DESAPONIFICATION**

Where caustic is added to crude prior to distillation, ash-forming materials resulting from such caustic are often present in fuel stocks. Petreco Electric Desaponification removes about 85% of such ash-forming constituents, enabling fuel stock to be marketed or to be used as a cracking charge.

**PETROLITE CORPORATION**
**PETRECO DIVISION**
3202 South Wayside Drive, Houston 1, Texas
1390 East Burnett Street, Long Beach 6, California

PC 53-2

tiny to
giant-sized bearings

# with TEAM-WORK built-in every size

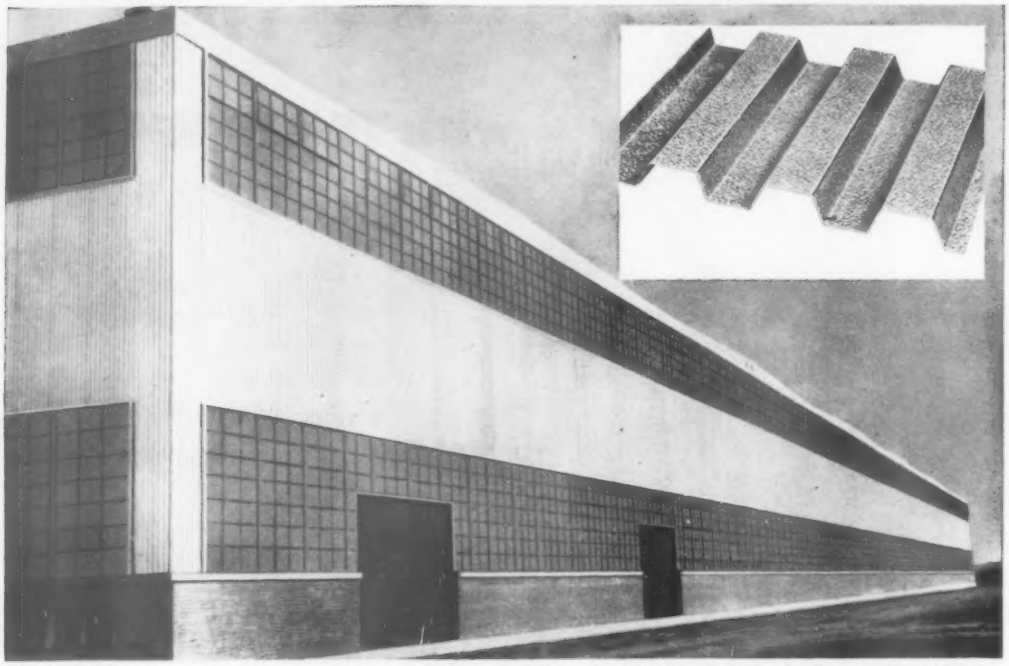
With every size in SKF's wide range of ball and roller bearings, you receive an extra quality—*team-work.* This is the ability of SKF field and home office engineers to cooperate productively with your equipment designers. Helping to solve their bearing problems is the *extra* which all industries have learned to expect from SKF.

7303

**SKF**
BALL AND ROLLER BEARINGS

**SKF INDUSTRIES, INC.,** PHILA. 32, PA.— *manufacturers of* **SKF** *and* HESS-BRIGHT *bearings.*

# NOW...ALUMINUM INDUSTRIAL SIDING WITH MODERN ARCHITECTURAL BEAUTY!



*General Contractors: Turner Construction Co., Struck Construction Co.*

One of the many large units at "Appliance Park," Buechel, Ky., where General Electric will consolidate its major appliance manufacturing. This new siding used throughout.

Here's the siding material industry has long sought! Sharp vertical lines in modern design, with all the advantages of rustproof, corrosion-resistant aluminum...low applied cost, long life, low maintenance (no painting), strength with light weight, heat-reflection that improves interior comfort summer and winter. No wonder this is what General Electric chose for siding throughout its vast new Appliance Park project. It ranks tops with architects, engineers, maintenance men and purchasing agents!

• • •

*Call Reynolds for literature and technical assistance on this new siding. For a material that performs as both roofing and siding, ask about Industrial Corrugated. Offices listed under "Building Materials" in classified phone books of principal cities. Or write*

Reynolds Metals Company, Building Products Division, 2023 South Ninth Street, Louisville 1, Kentucky.

**SPECIFICATIONS:**

**METAL THICKNESS:** 0.032" (22 U. S. Std. Ga.).

**FINISH:** Stipple-embossed.

**LENGTHS:** 5', 5½', 6', 6½' and so on to 13½'; also 13' 10". Special lengths to order.

**WIDTH:** Over-all width 33⅜", nominal coverage 32".

**RIBS:** Pitch 4" center to center, depth 1".

**WEIGHT:** 59 lbs. per 100 square feet.

**Military demands for aluminum reduce supply, but Reynolds is rapidly expanding production. Rated orders receive priority handling.**

## REYNOLDS *Lifetime* ALUMINUM RIBBED-EMBOSSED SIDING

**SEE "MISTER PEEPERS,"** starring Wally Cox, Sundays, NBC Television Network. **HEAR "Fibber McGee and Molly,"** Tuesdays, NBC Radio Network.

# This is Why the Nash is the Most Simple Compressor

# *It's the Nash!*

There are no mechanical complications in a Nash Compressor. A single moving element, a round rotor, with shrouded blades, forming a series of buckets, revolves freely in an elliptical casing containing any low viscosity liquid. This liquid, carried with the rotor, follows the elliptical contour of the casing.

The moving liquid therefore recedes from the rotor buckets at the wide part of the ellipse, permitting the buckets to fill with gas from the stationary Inlet Ports. As the casing narrows, the liquid is forced back into the rotor buckets, compressing the gas, and delivering it through the fixed Outlet Ports.

Nash Compressors produce 75 lbs. pressure in a single stage, with capacities to 6 million cu. ft. per day in a single structure. Since compression is secured by an entirely different principle, gas pumping problems difficult with ordinary pumps are often handled easily in a Nash.

Nash simplicity means low maintenance cost, with original pump performance constant over long periods. Data on these pumps sent immediately on request

**No internal wearing parts.**

**No valves, pistons, or vanes.**

**No internal lubrication.**

**Low maintenance cost.**

**Saves floor space.**

**Desired delivery temperature automatically maintained.**

**Slugs of liquid entering pump will do no harm.**

**75 pounds in a single stage.**

**NASH ENGINEERING COMPANY**

**313 WILSON, SO. NORWALK, CONN.**

# Call on Cyanamid for your chemical requirements...

## from oil well to oil can

Gelling Agents

Specialty Catalysts

Technical Service

AEROCAT® MS Synthetic Fluid Cracking Catalysts

Drilling Mud Compounds

AEROLUBE® Additives

Cyanamid service to the Petroleum industry is characterized by its ability, based on research, to meet the chemical requirements of the many distinct phases of that industry. Products of the Petroleum Chemicals Department range in application from drilling and refining to additives for lube oils and gelling agents for greases.

With specialists in each phase of production and refining, this integrated department is able to direct its product development work toward the solution of problems affecting the petroleum industry's flow-line from well to consumer.

Field experience bears this out: in one major oil-producing area, for example, 75% of the wells drilled over 6,000 feet have successfully employed Cyanamid's AEROPAN® SR-1 Drilling Mud Compounds.

**AMERICAN Cyanamid COMPANY**

**PETROLEUM CHEMICALS DEPARTMENT, DIV. 063**
**30 ROCKEFELLER PLAZA, NEW YORK 20, N. Y.**

**In Canada: North American Cyanamid Limited, Toronto and Montreal**

# PIPE LINE PROGRESS

## 24-inch Rancho Pipe Line increases crude supply to West Gulf Coast refineries

**Scheduled to start** operation on March 1st, the new large diameter Rancho Pipe Line System, running from McCamey to Houston, Texas, supplies crude oil to Texas Oil Refineries.

**Rancho's 467-mile** pipe line starts in west Texas sand and caliche, traverses 270 miles of rocky country to the vicinity of Austin, then crosses cultivated fields, rivers, pecan orchards and rice fields to the outskirts of Houston.

**Rancho is owned** by Shell, Sinclair, Pan-American, Crown-Rancho, Nantucket, Phillips and Ashland pipe line companies. Shell Pipe Line Corporation was responsible for construction, started in March of 1952, and now operates the line. A. O. Smith supplied 340 miles of 24-inch welded steel Line Pipe for this project.

**A. O. Smith** is proud to have contributed to the development of this and many other large diameter crude transmission pipe lines, making possible greater efficiency and economy in oil transportation.

*A. O. Smith Line Pipe is available in a complete range of sizes and wall thicknesses, from 8⅝-in. to 36-in. diameters.*

**FIRSTS by A. O. Smith: Welded line pipe • Internally expanded pipe • Light-wall large-diameter pipe • World's largest producer of large-diameter welded steel pipe.**

The A.O.Smith Casing Mill is operating at capacity to supply vitally needed casing for the Oil and Gas Industry.

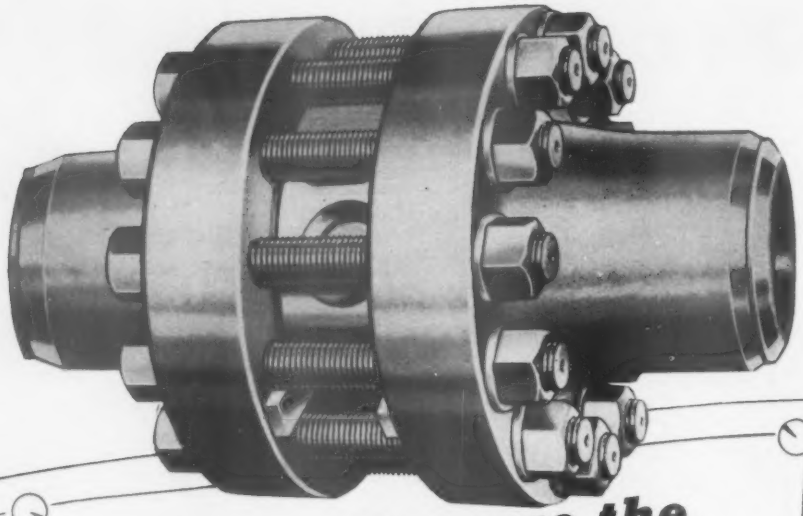
**A.O.Smith**

**CORPORATION**

**LINE PIPE • CASING**

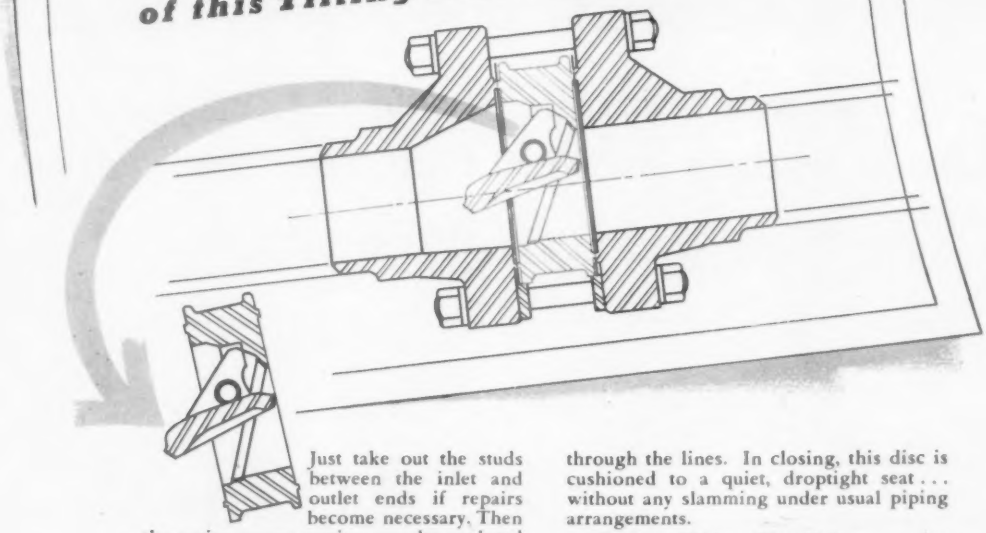
Chicago 4 • Dallas 2 • Denver 2 • Houston 2
Los Angeles 22 • Midland 5, Texas • New Orleans 12
New York 17 • Pittsburgh 19 • San Francisco 4
Seattle 1 • Tulsa 3 • Washington 6, D.C.
*International Division: Milwaukee 1*

***DEPENDABILITY THROUGH RESEARCH AND ENGINEERING***



# You Can Remove the Center Section

## of this Tilting Disc Check Valve



Just take out the studs between the inlet and outlet ends if repairs become necessary. Then the entire center section can be replaced . . . quickly and easily. No need to cut the valve out of a welded line.

The Tilting Disc Check Valve has the advantage of smooth, easy operation because of the balanced disc, which rides steadily and without fluttering in the flow through the lines. In closing, this disc is cushioned to a quiet, droptight seat . . . without any slamming under usual piping arrangements.

Chapman Tilting Disc Valves are also available in the standard two-piece design, in either iron or steel, for all pressures. Write for full details and prices to

***The Chapman Valve Mfg. Co.***
INDIAN ORCHARD, MASS.

**CHAPMAN 3-PIECE** TILTING DISC **CHECK VALVES**

# 693 mile Canadian Pipeline *in the Making . . .*

## Comstock-Midwestern Ltd. use LORAINS on 24 in. line

Comstock-Midwestern Ltd. are working on 472 miles of a 693 mile long line. 24-inch pipe for the Trans-Mountain Oil Pipe Line Co., will run from Edmondton, Alberta, to Vancouver, B. C. . . . and that means mile after mile of rocky, tough terrain.

One of the five Lorains in the Comstock-Midwestern equipment lineup, is a Lorain crawler crane, Model L50-K, equipped as a clamshell. Here it is shown clamming out a trench high up in the Rockies. This husky Lorain is mounted on an extra-long 14 ft. crawler that provides the extra flotation, reduced ground pressure and eliminates "nosing-in" when it is working on soft ground. The "50" is packed with performance features, including the famous Lorain Hydraulic Coupling, to answer the needs of pipeliners on rough, tough jobs like this one.

**LORAIN PIPELINERS ARE BUILT FOR PIPELINE DUTY**

If you will check the biggest pipeline spreads, you'll find more and more Lorains at work . . . because Thew-Lorain has specialized in equipment that best fills the need of this tough cross-country operation. Special pipeline features — such as, extra-long crawlers, non-heeling hoe buckets, towing lugs, sealed idler rollers to keep out mud and dust, replaceable tread pin bushings, hydraulic tread lock, air controls . . . and many other features in the Lorain line make for easy, profitable operation. You'll find Lorains embody the most preferred ideas for pipelining.

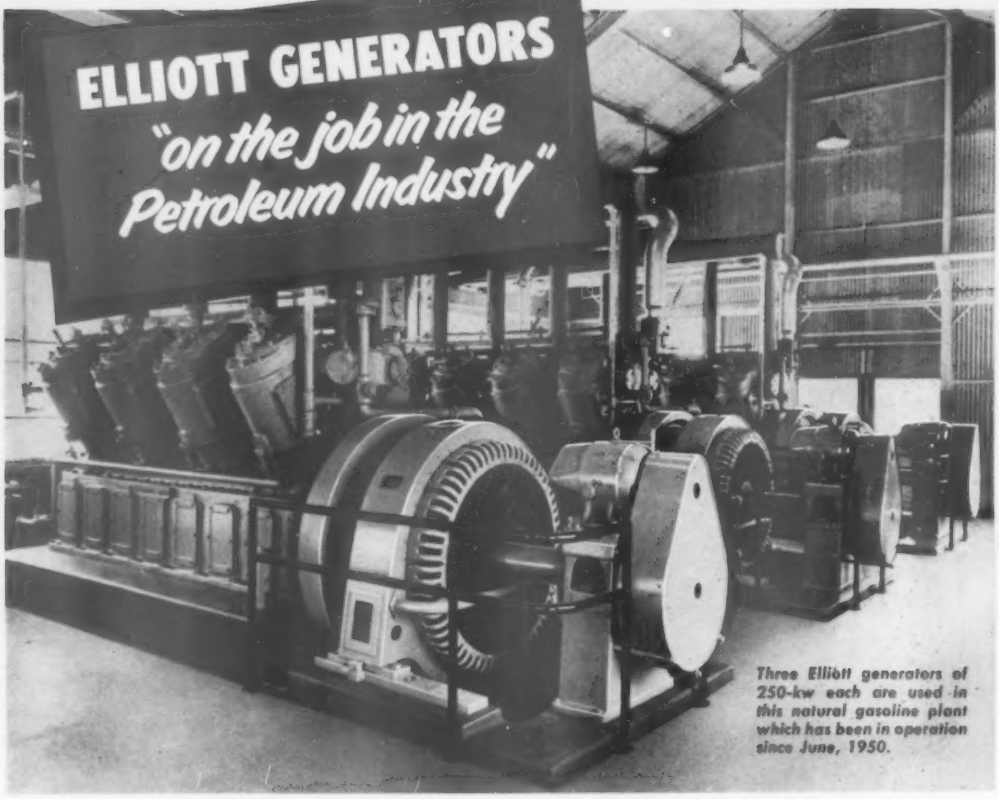
In addition, the Thew-Lorain line is the most complete. You can standardize on Lorains and fill your needs from the world's most complete selection of sizes, types and mountings. The reasons that Lorains blaze tough pipeline trails in the Canadian Rockies are the same reasons that it will pay you to standardize on the Lorain line for all YOUR pipeline needs. Thew distributors across the nation are ready to serve your spread . . . wherever it may be.

**THE THEW SHOVEL CO., LORAIN, OHIO**

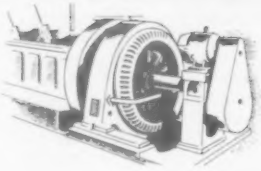
**PIPELINERS PREFER THE NAME**

**THEW LORAIN**

# ELLIOTT GENERATORS
## "on the job in the Petroleum Industry"



*Three Elliott generators of 250-kw each are used in this natural gasoline plant which has been in operation since June, 1950.*



**This very competent-appearing installation** supplies all necessary electrical power for pump drives, lighting, and other power needs in this natural gasoline plant in Texas.

The three generators are Elliott units, 250-kw each, driven by Ingersoll-Rand gas engines. In these generators Elliott "Fabri-Steel" construction is used throughout, providing the highest degree of rigidity plus the strength that only steel can give. Note that easy access to the rotor is gained swiftly by removing the bolts in the stator feet and sliding the stator along the extension of the bed, to clear the rotor.

For full data on Elliott generators, consult your local Elliott representative, or write Elliott Company, Ridgway, Pa.

Elliott FABRI-STEEL MOTORS AND GENERATORS

**ELLIOTT Company**

***RIDGWAY DIVISION***

R3-2

# People *will talk*

開密克幫我們發展工業。
"Chemico helped us develop our industry"

**"Chemico" heeft ons meer gegeven dan wij verwachtten.**
"Chemico gave us more than we expected"

«كيميكو» رتّبه
"It's designed by Chemico"

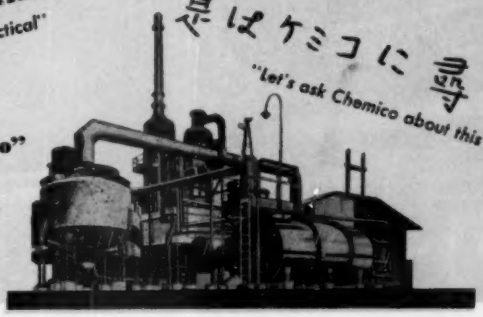
"केमिको" ने सारा काम किया।
"Chemico did the whole job"

**"Chemico" comprend nos problèmes.**
"Chemico understands our problems"

**"CHEMICO" SABE SE É PRÁTICO.**
"Chemico knows whether it's practical"

ケミコに尋ねよう!
"Let's ask Chemico about this"

**La reputación de "Chemico" nos ha persuadido.**
"Chemico's reputation sold us"



When our representatives travel to the far corners of the earth, they find that word of Chemico's activities has gone before them.

Yes, people *will* talk . . . and carry the news of Chemico accomplishments in the design and construction of plants for the production of heavy chemicals: fertilizers for India, Mexico, the Philippine Islands and Egypt; sulfuric acid for Canada, England, Formosa and Brazil; urea for Japan; sulfur recovery for Colombia; pickle liquor recovery for the Union of South Africa, to name a few. And naturally these are in addition to numerous large-scale projects in the United States.

Chemico has created, designed and erected more than 800 installations during the past 37 years that have given people much to talk about. That's why "Discuss it with Chemico" has become a byword of those who need new facilities or additional plant capacity to meet the world's ever-expanding heavy chemical needs.

**CHEMICAL CONSTRUCTION CORPORATION**

A UNIT OF AMERICAN CYANAMID COMPANY

488 MADISON AVENUE, NEW YORK 22, N. Y.

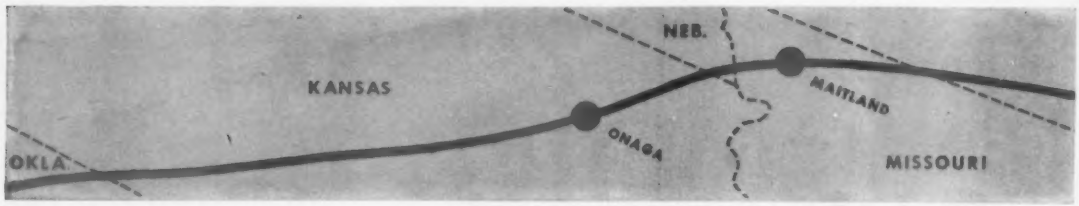
CABLES: CHEMICONST, NEW YORK

TECHNICAL REPRESENTATIVES: CYANAMID PRODUCTS LTD., LONDON • CHEMICAL CONSTRUCTION (INTER-AMERICAN) LTD., TORONTO • SOUTH AFRICA CYANAMID (PTY) LTD., JOHANNESBURG

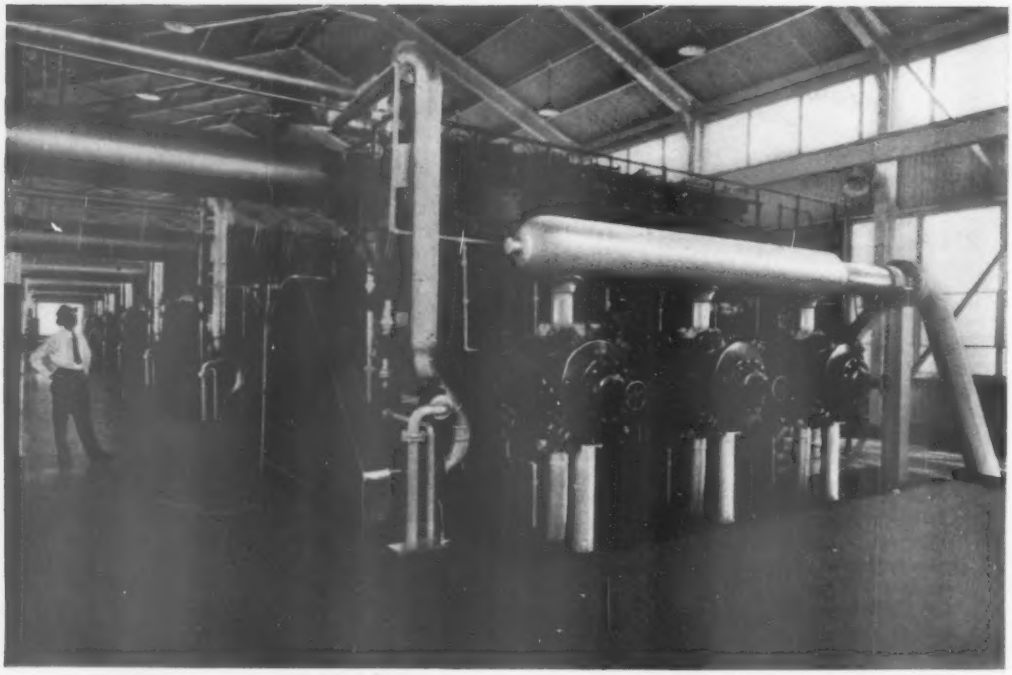
CHEMICO

*Chemico plants are profitable investments*

CC-250




# Michigan-Wisconsin Operates 27 Worthington



**Six Worthington UTC Engine-Compressors,** each rated at 1,400 hp, 320 rpm. Installation is at New Windsor, Illinois, station No. 9 of the Michigan-Wisconsin Pipe Line Company. Each engine uses Worthington's scientifically developed unifto thru-scavenging system.

NO OTHER COMPRESSOR WILL

# Pipe Line Company Engine-Compressors

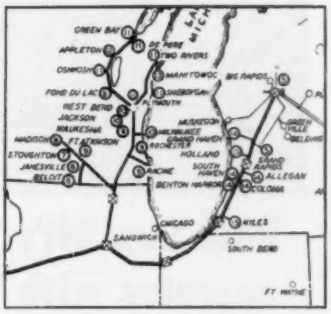
## Big 1,400-hp UTC's move gas through 3 stations along line

The pipeline that brings natural gas to Detroit from northern Texas also feeds most of Wisconsin and eastern Michigan.

Three of the compressor stations are equipped with Worthington UTC gas-engine compressors—eighteen in all, a total of 25,000 horsepower. The sure-fire, highly efficient performance of these units, and many others like them, is your best evidence of the advantages offered by Worthington's uniflo timed-scavenging system that thoroughly removes burned gases.

But the UTC has many uses other than as a pipeline gas-engine compressor. It can perform with equally high efficiency on oil wells for pressure maintenance . . . in oil refineries for solvent extraction, vapor recovery, recycling and stabilization of gases . . . in natural gasoline plants . . . in petrochemical processing of products made from natural gas under pressure . . . and in many refrigeration applications.

Built in sizes from 1,000 to 2,000 hp, the uniflo UTC will improve *your* process, if it requires gas compression. All you need is a suitable gas for fuel. Your nearest Worthington district office can give you full information, or you may write directly to Worthington Corporation, Engine Division, Buffalo, New York.




**Delivering Gas to Industrial Detroit,** the Michigan-Wisconsin Pipe Line Company draws from the Texas Panhandle, with many utilities buying right off the line en route. Operating at its maximum capacity of 343 MMCF per day, this line is one of the few operating at the same capacity throughout the year. A tremendous storage field near Big Rapids, acting as a reservoir for the whole area, takes care of winter demands, absorbs summer pipeline surplus. To keep the gas moving, the pipeline uses Worthington UTC engine-compressors in 3 of its stations. Also used at two other stations are nine Worthington twin-tandem horizontal gas-engine compressors totaling 14,400 hp.

OUTPERFORM A WORTHINGTON

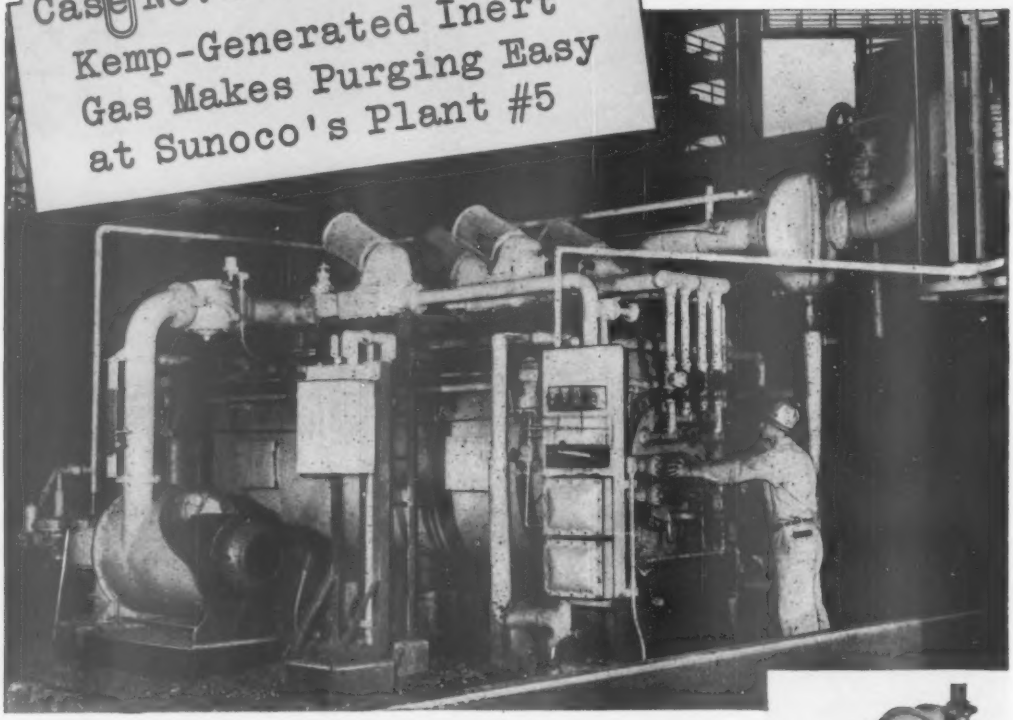
EK.2.3

WORTHINGTON

Engine Compressors

Case No. 57

Kemp-Generated Inert Gas Makes Purging Easy at Sunoco's Plant #5



# How Sun Oil's "Magic Mill" at Toledo operates with 'round the clock safety

There's no *one* word that strikes terror in the hearts of oilmen everywhere more quickly than F-I-R-E! To combat this threat at the Sun Oil Co.'s giant refinery at Toledo, Ohio, constant vigilance, checks and inspections are the answer. And the liberal use of inert gas for purging pipelines, tanks and crackers is essential to this safety maintenance.

**Kemp selected to do the job**

When plans called for *doubling* plant production in 1950, a new Kemp Generator (see above) was installed to insure adequate inert gas production. Fast-starting, easy-to-operate, this Kemp unit more than filled the bill. Today tanks and lines are periodically purged for inspection and cleaning *as often as needed*. And thanks to its 60,000 cu. ft. per hr. Kemp Inert Gas Generator, Sunoco enjoys *exact analysis* inert production that meets all its purging requirements.

**Let Kemp help you, too**

If you have a purging or blanketing problem, why not let Kemp Engineers give you the same helpful advice used so profitably at Sun Oil's Toledo refinery. It costs you nothing to investigate. And it may save you money. Find out how Kemp's wide range of dependable, low-cost Generators (complete with the latest fire checks and safety devices) offer you the best way to solve your problems.

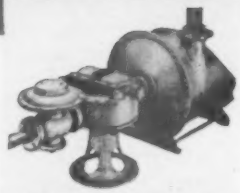
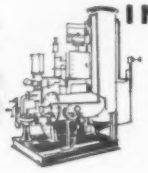


**Photo above shows close-up view of Kemp Industrial Carburetor, the heart of every Kemp installation. Assures complete combustion... without waste, without tinkering. Reduces installation costs, simplifies maintenance.**

***For more complete facts and technical information, write for Bulletin I-10 to:***
**C. M. KEMP MFG. CO., 405 E. Oliver Street, Baltimore 2, Maryland.**

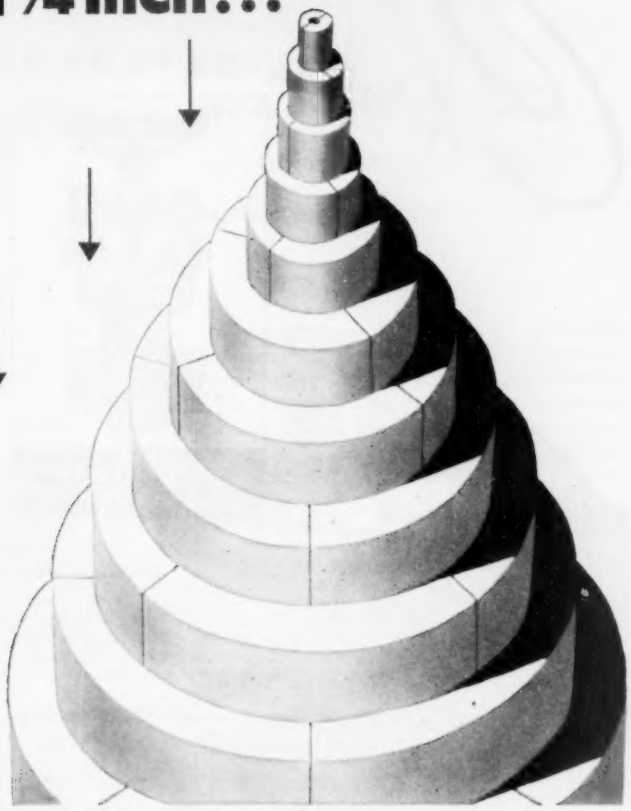
**KEMP OF BALTIMORE**



**INERT GAS GENERATORS**

**CARBURETORS • BURNERS • FIRE CHECKS**
**METAL MELTING UNITS • ADSORPTIVE DRYERS • SINGEING EQUIPMENT**

# For Radii from ¼ Inch...



to

# Infinity...

## Nesting Kaylo Heat Insulation Requires Fewer Pieces Per Job

The complete range of Kaylo Insulation includes pipe covering in Simplified Dimensional Standards for diameters from ¼ in. to 72 in., curved block from 72 in. to 60 ft. and flat block for surfaces of less curvature whose radii approach infinity. With its wide selection of interchangeable sizes and shapes, Kaylo Insulation reduces the number of items needed per job and permits substantial savings in warehousing maintenance stock.

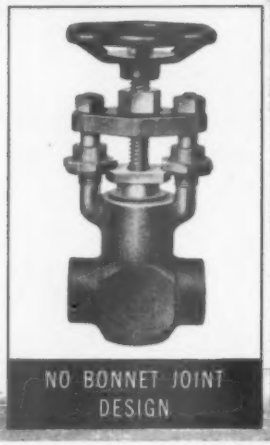
**WRITE FOR FREE BOOK**—"Kaylo Heat Insulation." Address: Dept. N-359, Owens-Illinois Glass Company, Kaylo Division, Toledo 1, Ohio.

**KAYLO**® ***...first in calcium silicate***

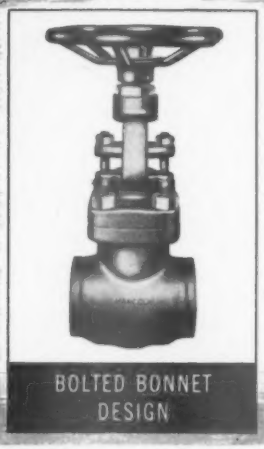
***...pioneered by*** OWENS ILLINOIS **Glass Company**

MAIN OFFICE: TOLEDO 1, OHIO—KAYLO SALES OFFICES: ATLANTA • CHICAGO • HOUSTON • NEW YORK • PHILADELPHIA • PITTSBURGH • ST. LOUIS

# Choose THE TYPE YOU LIKE BEST



NO BONNET JOINT DESIGN



BOLTED BONNET DESIGN

**800# GENERAL PURPOSE**
**HANCOCK STEEL GATE WELDVALVES**

Extra years of trouble-free dependability. Long-life economy. 800# Hancock Steel Gate Weldvalves give you both. Select either "no bonnet joint" or bolted bonnet design — incorporated in them are exclusive construction and operational features that have proved their value in the severest services. Yet they cost no more than ordinary valves.

**Among the many superiorities built into these valves are:**

**1.** Maximum use of super-strong, leak-proof welding.

**2.** Integral Stellite seats.

**3.** "500 Brinell" stainless steel wedges.

**4.** No galling because dissimilar materials are used for the accurately finished and perfectly aligned seats and wedges.

**5.** No stem pitting.

**6.** Corrosion-resisting back seating.

**7.** Extra-strong upper structure.

**8.** Repacking ease.

**9.** Safe, comfortable handwheel — designed to operator specifications.

**10.** Complete interchangeability of parts that saves time, trouble, money.

**11.** Baked enamel exterior finish for maximum protection.

**SIZES:** *No Bonnet Joint Design*—¼" through 2". *Bolted Bonnet Design*—1¼" through 2".

**CONNECTIONS:** Screwed ends . . . socket weld ends . . . flanged ends.

**SERVICE RATINGS:** For *all* pressures up to 800 psi at 750° F.—O.W.G. 2000# 100° F.

Hancock Steel Gate Weldvalves do a job and stay on the job. Complete information about the type you like best is available through your Hancock Valve Distributor. Get in touch with him today.

**MANY ADVANTAGES ARE YOURS** through the complete services of your Industrial Distributor. He anticipates your needs—maintains stocks of many top-quality items —saves time and money for you with fast deliveries in emergencies.

**When Hancocks go in, valve costs go down.**

# HANCOCK VALVES

A product of **MANNING, MAXWELL & MOORE, INC.** WATERTOWN 72, MASSACHUSETTS

MAKERS OF 'HANCOCK' VALVES, 'ASHCROFT' GAUGES, 'AMERICAN' INDUSTRIAL INSTRUMENTS, 'CONSOLIDATED' SAFETY AND RELIEF VALVES. BUILDERS OF "SHAW-BOX" AND 'LOAD LIFTER' CRANES, 'BUDGIT' AND 'LOAD LIFTER' HOISTS AND OTHER LIFTING SPECIALTIES.

# Tested patterns to meet today's needs . . .

## Jenkins cast steel Valves

**for dependable economy**

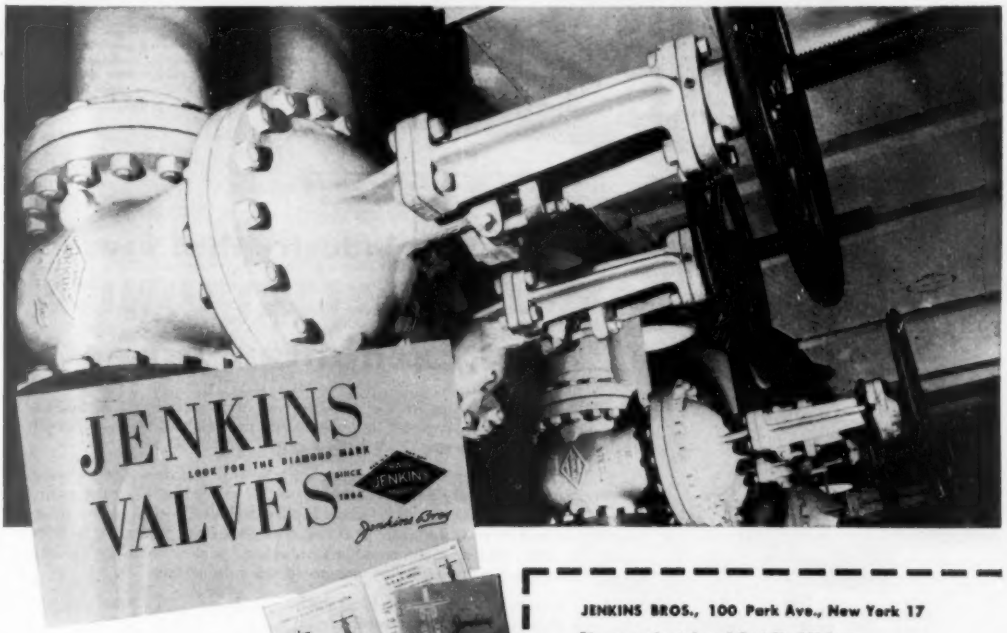
**in high pressure**

**—higher temperature services**

Mounting pressures and temperatures in power generation and industrial processing call for Cast Steel Valves. For this increasing need, Jenkins offers a wide selection of patterns that have met the test of the toughest services throughout industry.

In these valves, Jenkins provides a wide margin of strength and safety beyond ratings. Special refinements in design extend their service life, assure long, trouble-free performance. Efficiency and low maintenance records measure up to the high standards established for all valves developed by Jenkins Valve *specialists*.

The new Cast Steel Valve catalog gives complete information. Write for your copy today. Jenkins Bros., 100 Park Ave., New York 17.




**Get this NEW Cast Steel Valve Catalog**

Describes Globes, Angles, Gates, and Checks with detailed pressure ratings, dimensions, and other technical data covering all patterns of Cast Steel Valves now available from Jenkins. Send the coupon for your copy.

**JENKINS BROS., 100 Park Ave., New York 17**

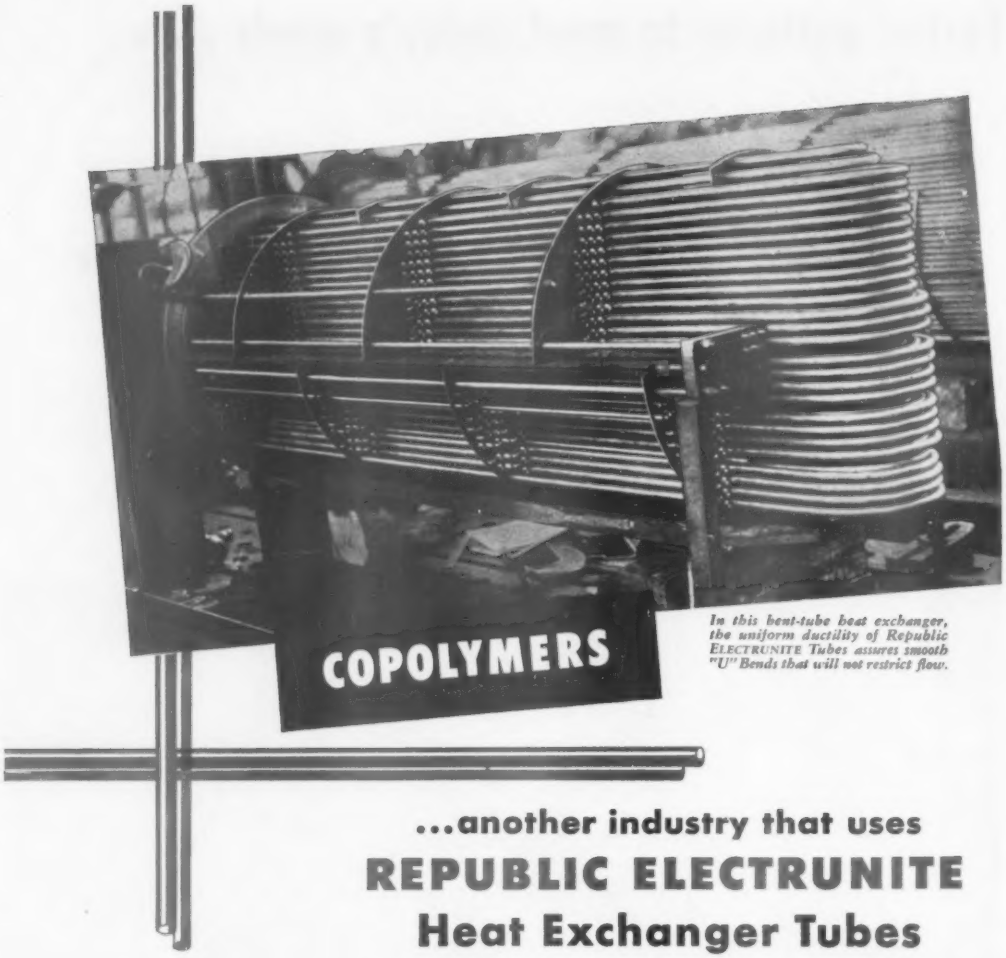
**Please send catalog of Cast Steel Valves.**

**Name**.....

**Company**.....

**Address**.....

.....




*In this bent-tube heat exchanger, the uniform ductility of Republic* ELECTRUNITE *Tubes assures smooth "U" Bends that will not restrict flow.*

## ...another industry that uses

# REPUBLIC ELECTRUNITE
# Heat Exchanger Tubes

● At almost all stages in the production of copolymers, Republic ELECTRUNITE Tubes are used in heaters, condensers, and other types of heat exchange equipment.

The ELECTRUNITE process of making carbon and stainless electric-weld tubing from uniformly flat steel assures you of tubes that are concentric, uniform in wall thickness, and uniform in diameter all around the tube, and from end to end. Republic ELECTRUNITE Tubes can be smoothly bent even to short radii. Full-normalized treatment makes them uniformly ductile for predictable roller-expansion in the tube sheets.

Specify Republic ELECTRUNITE Heat Exchanger Tubes. Equally economical on new equipment or for retubing.

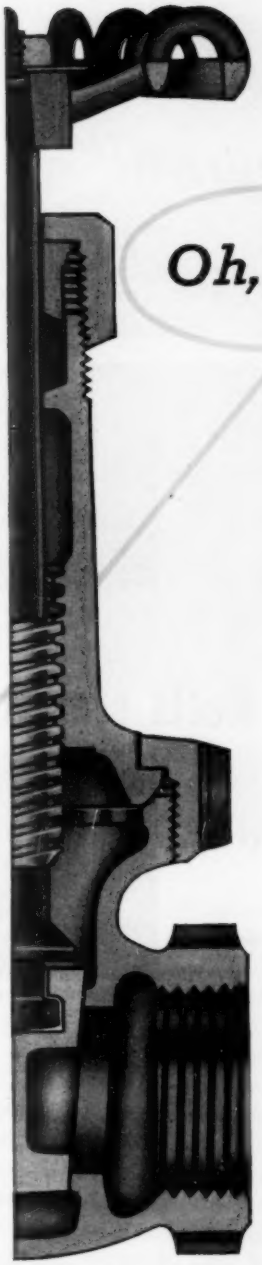
**WRITE FOR "BOOKLET SPI-53"** which gives useful data and specifications on Republic ELECTRUNITE Pressure Tubes, both carbon and stainless.

**STEEL AND TUBES DIVISION**
**Republic Steel Corporation**
219 East 131st Street • Cleveland 8, Ohio

REPUBLIC STEEL

Republic
ELECTRUNITE
BOILER, CONDENSER AND HEAT EXCHANGER TUBES

# This valve is packed with 70 years' experience



*Oh, I see*

OIC's "7200 Line", the bronze valve that 70 years' experience built, incorporates the most advanced engineering, superior workmanship and the finest materials . . . its union bonnet, copper-nickel wedge and long-wearing OIC Alloy 40 stem, for example. You see the difference in the dependability, economy and long, maintenance-free life which OIC Bronze Valves give you.

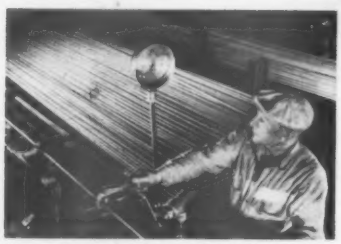
**THE OHIO INJECTOR COMPANY**
**WADSWORTH, OHIO**

OIC
FOUNDED 1883

**VALVES** . . . **FORGED & CAST STEEL, IRON & BRONZE**

# Chase Antimonial Admiralty

(a patented alloy)



Every Chase Antimonial Admiralty heat exchanger tube is tested to withstand at least 1,000 pounds per square inch water pressure.

## Meets every test for Heat Exchanger Tubes

Chase flattening test, index of Antimonial Admiralty tube's physical quality and ability to withstand bending or end flaring.

This Chase metallurgist is checking the size and uniformity of grain of Chase Antimonial Admiralty heat exchanger tubes.

When you put Chase Antimonial Admiralty* tubes into a heat exchanger you *know* they'll stand up for years. It isn't only that we make certain there's enough antimony to resist dezincification. Chase heat exchanger tubes are carefully tested and retested for *every* physical and chemical property required to meet actual field conditions. It pays to insist on Chase Antimonial Admiralty.

*U. S. Pat. No. 2,061,921

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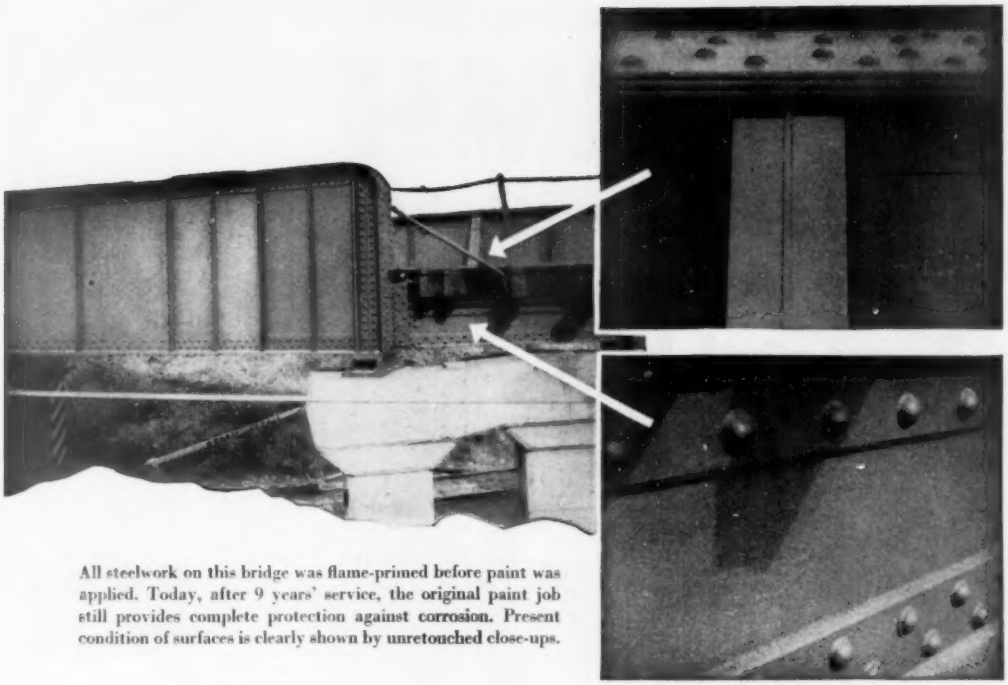
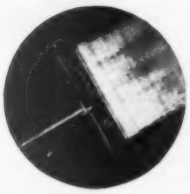


All steelwork on this bridge was flame-primed before paint was applied. Today, after 9 years' service, the original paint job still provides complete protection against corrosion. Present condition of surfaces is clearly shown by unretouched close-ups.

## *Your Steelwork . . .*

# *How Will It Look in 1960?*



Steelwork you coat with good paint today can still look like new ten years from now, *if you flame-prime all exposed surfaces first.* And what you'll save on maintenance, because of increased protection due to flame-priming, will more than pay for all the flame-priming apparatus and materials you need for the job.

Flame-priming is simple to do, requires little equipment, and costs little. A brush of oxy-acetylene flames pops off scale and drives out moisture. Paint applied to the warm, dry surface goes on quickly and smoothly, bonds tightly, and lasts longer.

Flame-priming is one of many time- and money-saving LINDE methods for making, cutting, joining, treating, and forming metals. So, whatever you do with metals, there is a good chance that LINDE know-how, show-how, and equipment can help you do it better, more quickly, or at lower cost.

To find out, without obligation, telephone or write our nearest office today. LINDE AIR PRODUCTS COMPANY, a Division of Union Carbide and Carbon Corporation, 30 East 42nd Street, New York 17, N. Y. Offices in Other Principal Cities. In Canada: Dominion Oxygen Company, Limited, Toronto.

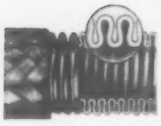
Linde Trade-Mark

**Products and Processes for MAKING, CUTTING, JOINING, TREATING, AND FORMING METALS**

The term "Linde" is a registered trade-mark of Union Carbide and Carbon Corporation.

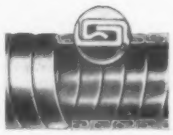
# CMH

## One dependable source for every flexible metal hose requirement



CMH corrugated hose is available with metal braid covering or unbraided in steel, bronze or stainless steel. Used where great flexibility is required at high temperatures and high pressures. Sizes range from ¾" I.D. to 24" I.D. Depending on size, type and material, it will handle burst pressures to 12,000 psi, temperatures to 1200° F.

CMH interlocked hose is available in various types, packed and unpacked, in steel, stainless steel, bronze, aluminum, brass and other metals. It is used for steam, exhaust, tar and asphalt, etc. Sizes ½" to 12", I.D. Depending on size, type and material, it may be used for working pressures to 750 psi (constant), temperatures to 600° F.

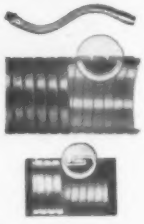


CMH double groove (ball bearing design) hose is available in bronze, steel or stainless steel with asbestos packing and with or without metal braid covering. Widely used for non-searching liquids and gases at low to moderate pressures and temperatures. Sizes range from ⅛" to 1¼", I.D.

CMH square locked hose is available unpacked or with a choice of several types of packing in steel, bronze, brass, aluminum, stainless steel, etc. It is used as conduit, cable armor, nozzles and many similar applications. Sizes range from ⅜" to 1", I.D. Normally used only at very low pressures.

*For full information on all CMH hose products write for Catalog 130 or see the Flexonics catalogs in Sweet's Plant Engineering File, Chemical Engineering Catalog and The Refinery Catalog. For maintenance hose, see the classified pages of your telephone directory for the name of your CMH distributor.*

Standard assemblies and special purpose flexible metal hose items are manufactured for such services as steam, tar and asphalt, machine tool coolants, machine tool wiring conduit, dry granular products. We will be pleased to send data on any specific requirement.



**CHICAGO METAL HOSE Division**

**Flexonics** *Corporation* 1345 South Third Avenue, Maywood, Illinois

In Canada: Flexonics Corporation of Canada, Ltd., Brampton, Ontario

Flexon identifies CMH products that have served industry for over 50 years.

CMH

Flexible metal hose

Expansion joints

Aircraft components

Metallic bellows and bellows assemblies

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## It's NEW... It's FREE!

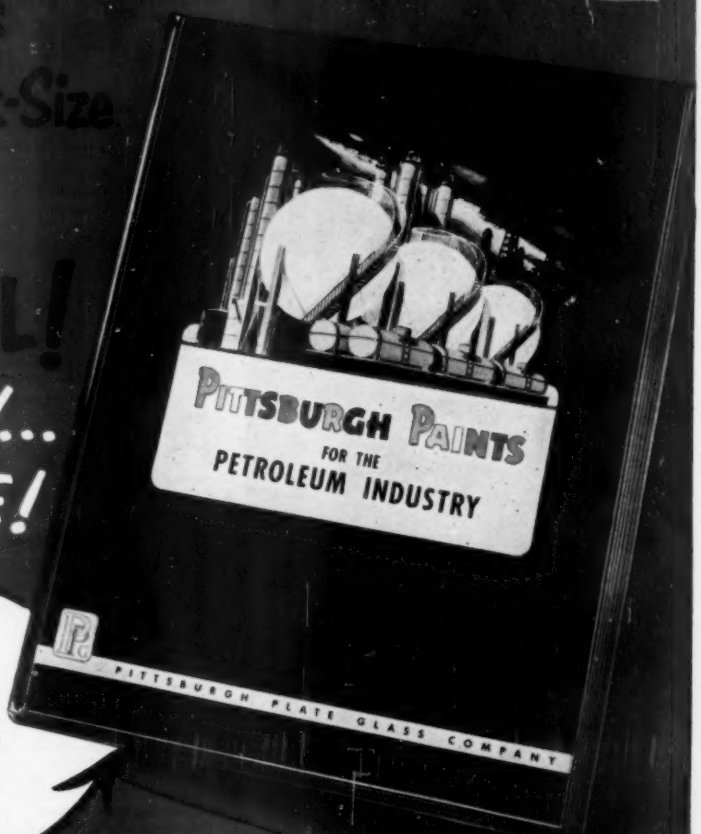


**Table of Contents Includes:**

1. Product description.
2. Application recommendations.
3. Large-size color chips.
4. Inspection, surface preparation and painting of storage tanks.
5. General maintenance and painting suggestions.
6. Recommendations for painting automotive equipment.
7. How to use COLOR DYNAMICS painting system.

PITTSBURGH has just issued a highly practical manual of information for those who buy and use paints in the petroleum industry.

● **This ready reference volume** contains complete descriptions of all Pittsburgh Paints for this field. These finishes are the finest it is possible to make. Their formulations are the result of the latest and best knowledge developed by Pittsburgh's large and skilled technical staff. Among its advancements are special *"Vitolized Oils"* and the process of molecular selection which have contributed so much to the exceptionally high-level performance of these coatings.

● **Also included** in this manual are numerous suggestions for proper application and maintenance. Many of these have been derived from Pittsburgh's long experience in supplying leading petroleum producers with high-quality finishes that have proved to be unusually successful in beautifying and preserving many types of surfaces.

● **By keeping this manual** handy you may be able to save time and money. We'll be glad to send you a copy without cost or obligation. Just fill out and mail coupon below, with one of your company's letterheads.

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**EFFICIENT AND DEPENDABLE STEAM GENERATION**

Vogt steam generating units are designed to give maximum rating in a minimum of space with high efficiency and low maintenance expense. Bent tube types and straight tube, forged steel sectional header types to burn solid, liquid or gaseous fuels, as desired, meet every power, heating or process requirement.

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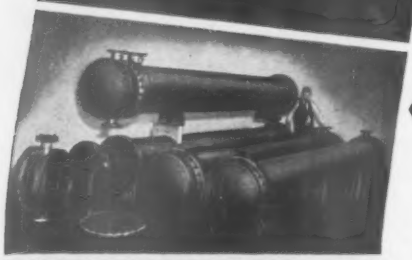
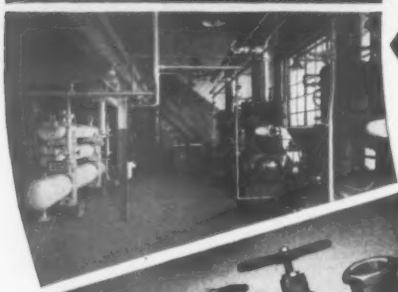
Stills, towers, oil chilling machines, filter presses, heat exchangers, etc. are constructed to all Codes. They meet all demands for operating security and trouble-free performance and help to lower costs in important process industries around the world.



**SPECIAL MATERIALS FIGHT CORROSION AND PRODUCT CONTAMINATION**

Our modern shops produce a wide variety of equipment made from special metals and alloys to combat corrosion, and product contamination or discoloration. Fabrication procedures employed insure that corrosion resistant properties of welds will match that of the materials from which units are constructed.



**MORE TONNAGE AT LESS COST**

Over 60 years of manufacturing experience, engineering and research stand behind Vogt refrigerating and ice making machinery. Absorption Systems, Compression Systems, and the Automatic Tube-Ice Machine in a wide range of capacities serve in leading petroleum refineries, chemical plants, ice and cold storage plants, dairies, packing plants, etc., at home and abroad.

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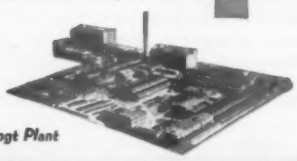
Vogt valves, fittings and flanges, for top performance in oil, water, air, gas, and ammonia services, at high or low pressures and temperatures, are available drop forged entirely from carbon steel or stainless steel. Valves can be furnished in a combination of materials by using stainless steel for parts affected by service temperature or corrosion, and less expensive alloys or carbon steel for other parts.



*Air View of Vogt Plant*

**HENRY VOGT MACHINE CO.**

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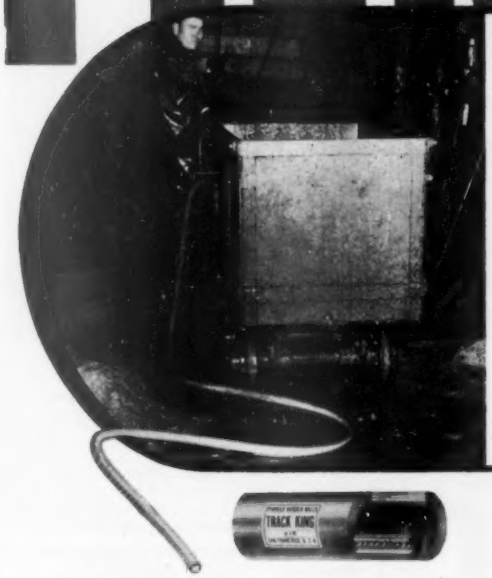
BRANCH OFFICES: NEW YORK, PHILADELPHIA, CLEVELAND, CHICAGO, ST. LOUIS, DALLAS

## Industrial rubber products especially built for LONG SERVICE

# PIONEER




**"Toughest, Lightest Hose We Could Find"**

**A NEW DEVELOPMENT—PIONEER TRACK KING**

**TRACK KING gets its exceptional strength and light weight through use of a tightly woven, tough nylon reinforcement. Its cover is abrasion and impact-resistant Pioneer Rubber—bright yellow for peak visibility.**

The arrival of Pioneer TRACK KING was a revelation to the men digging this wet, narrow Seattle sewer tunnel. After a long struggle with ordinary cumbersome pneumatic hoses, it was really a pleasure to handle TRACK KING. And yet it proved more capable of taking the unusually tough punishment found on this 1400-foot tunnel job.

Air hose was important because drilling, shoring, and transporting were all done pneumatically. The workmen not only had to contend with the cramped conditions of a nine-foot face, but also had to fight 52,000 gallons of seepage a day.

Pioneer TRACK KING made the best of this tough, crowded assignment. The men said they hardly noticed this light weight hose on their pneumatic tools, in contrast to previous bulky hoses. It improved the efficiency of every tool on the job.

Regarding its strength, Walter Carlson, the superintendent, said this: "In spite of the watchfulness of the men and the bright yellow cover, the trucks ran over the hose five or six times a day *with no apparent damage.*"

In getting this tough tunnel job under way the Valley Construction Company tried nearly every premium pneumatic hose on the market. But they were really enthusiastic when they found exactly what they wanted in TRACK KING.

Investigate Pioneer TRACK KING, yourself. It is the lightest, strongest air hose you can buy. Ask your Pioneer representative for complete details on this and the many other Pioneer industrial rubber products available now.

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***be sure you get***

# SERVICE

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The Tretolite Company sells no desalting equipment. Our interest in your desalting plant design is based only on one desire: to make sure your desalting plant is set up so you get maximum desalting performance from the chemical used. We believe we sell the best desalting chemicals available—we know we give the best service. Just give us a chance on your next desalting installation.

*To assure maximum desalting efficiency, the Tretolite Company provides a complete service department, staffed by experienced desalting engineers. When you specify Tretolite desalting, you are assured of*

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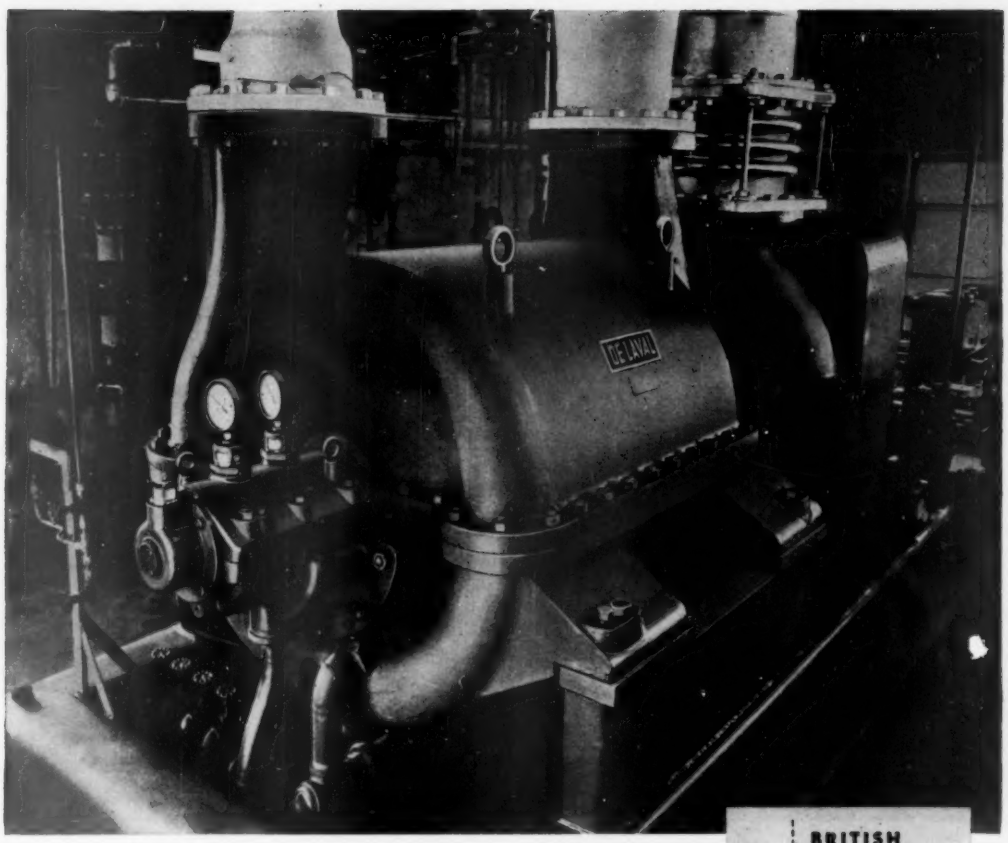



# *This blower never takes a "breather"*

*at* BRITISH AMERICAN OIL COMPANY

The clock never stops on this De Laval catalytic cracking blower in the Edmonton, Alberta plant of the British American Oil Company. Twenty-four hours a day this 885 hp, 8,250 cfm unit handles air for the regeneration of the spent catalyst.

There are good reasons for this power-saving dependability. This heavy-duty machine is built to take punishment. Its rugged casings, husky, perfectly balanced rotor and externally mounted, cylindrically seated bearings are design features that reduce maintenance and insure long, continuous service. Remember, there's no divided responsibility—both turbine and blower are De Laval designed, and De Laval made.

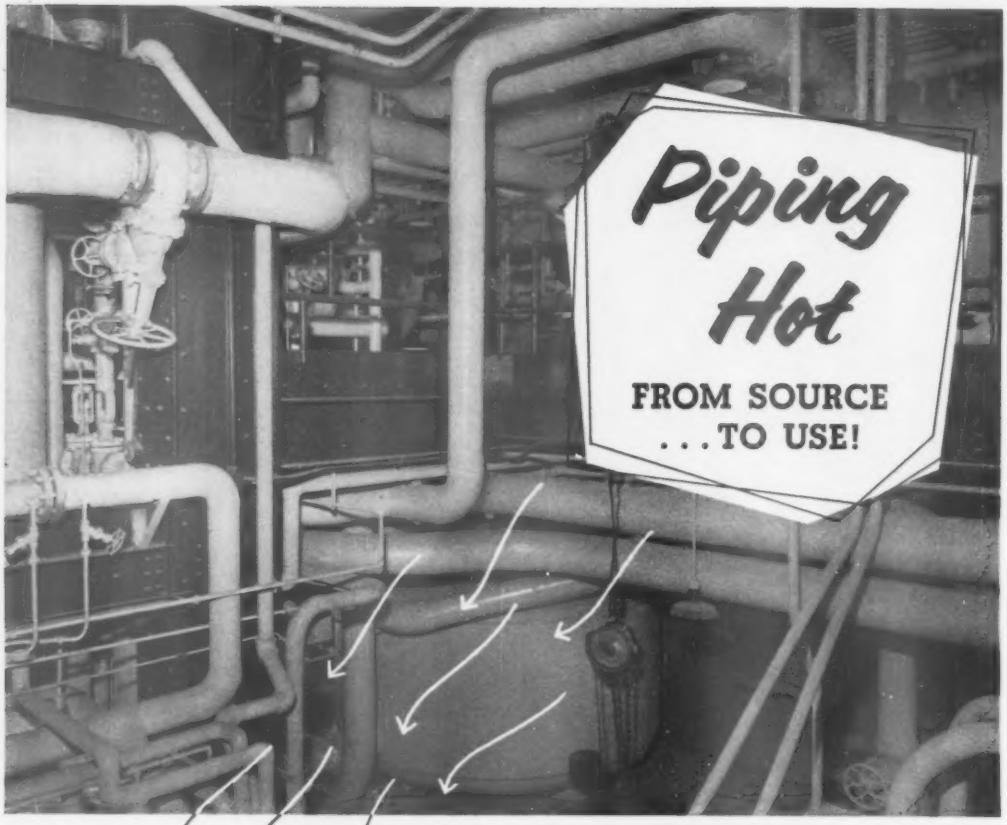
De Laval blower experience covers a wide range of industries—steel, refining, metal mining, chemical processing, high pressure gas transmission, manufactured gas, sewage aeration and many others. And all this engineering and manufacturing experience is ready to solve your specific blower application. Discuss it with a De Laval representative.

*Send for Bulletin 0500 containing complete data*

**DE LAVAL** *Centrifugal Blowers*

DE LAVAL STEAM TURBINE COMPANY
*810 Nottingham Way, Trenton 2, New Jersey*

DL 188

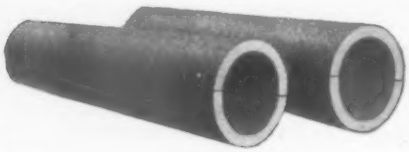



UNARCO

# Unibestos®

**PIPE INSULATION**

**for Temperatures up to 1200°F**



High thermal efficiency! That's one of the features of Unibestos Pipe Insulation. It's an outstanding b.t.u. barrier.

Yes, and it's easy to fit—cuts quickly, cleanly. And Unibestos lasts and lasts because it's highly resistant to moisture, fumes, vibration, and impact.

That's why you're finding more Unibestos in more plants every day. It's made in cylinders and half-rounds in two types: No. 750 for temperatures up to 750°F.; No. 1200 for up to 1200°F. And it's also available in block-form for up to 1200°F. uses.

Phone your nearby Unarco Distributor for recommendations and prompt service on Unibestos, Amocel, and other dependable Unarco insulations. For new installations or replacements, there's nothing better.

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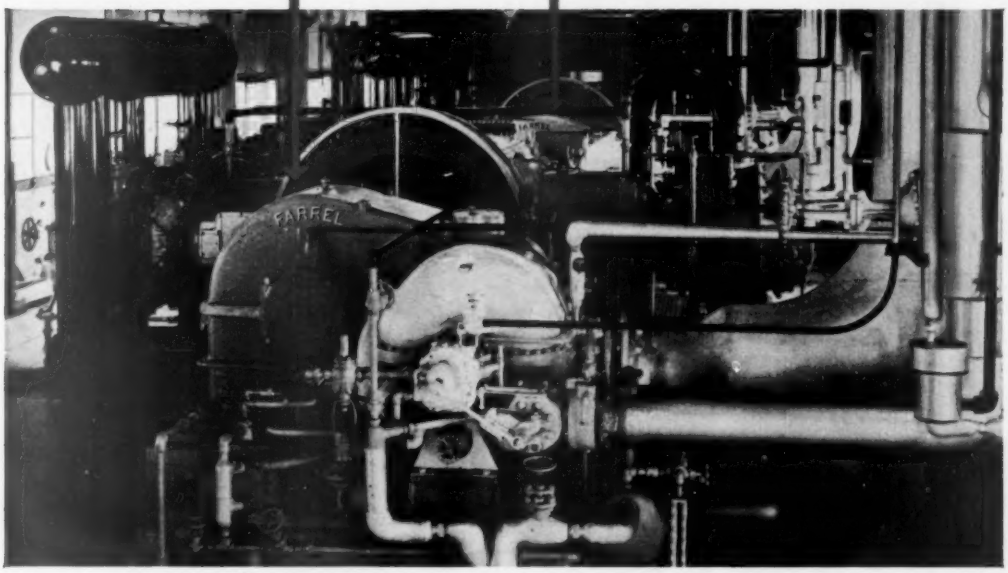
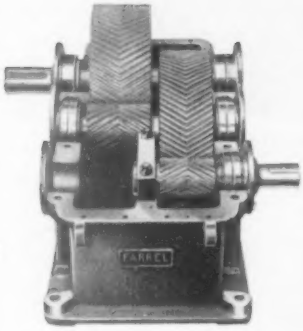
# THESE SPEED REDUCERS HANDLE

## A TOUGH JOB WITHOUT COMPLAINT




Each of these Farrel® double-reduction gear units is transmitting 920 HP from a turbine to a Cooper-Bessemer M-Line compressor. They are located at the Billings (Montana) refinery of Continental Oil Company.

This is a difficult assignment for any speed reducer. The high-speed operation (4000/300 RPM) really "tests" the design and workmanship of the gear unit.

How well these two Farrel units have performed on this tough job is a matter of record—almost three years of continuous operation, with a minimum of down time for routine inspection and maintenance.

Farrel speed reducers have a number of advantages which account for their outstanding performance records. The quiet, vibration-free operation of the herringbone gears results from extreme acccuracy of tooth spacing, contour and helix angle—qualities inherent in the Farrel-Sykes method of gear generation. Precision manufacture and highest-grade materials contribute to long gear life.

*Write for further details of these outstanding units. Ask for a copy of Bulletin 449.*

**FARREL-BIRMINGHAM COMPANY, INC., ANSONIA, CONN.**

*Plants:* Ansonia and Derby, Conn., Buffalo, N. Y.
*Sales Offices:* Ansonia, Buffalo, New York, Boston, Pittsburgh, Akron, Detroit, Chicago, Memphis, Minneapolis, Portland (Oregon), Los Angeles, Salt Lake City, New Orleans

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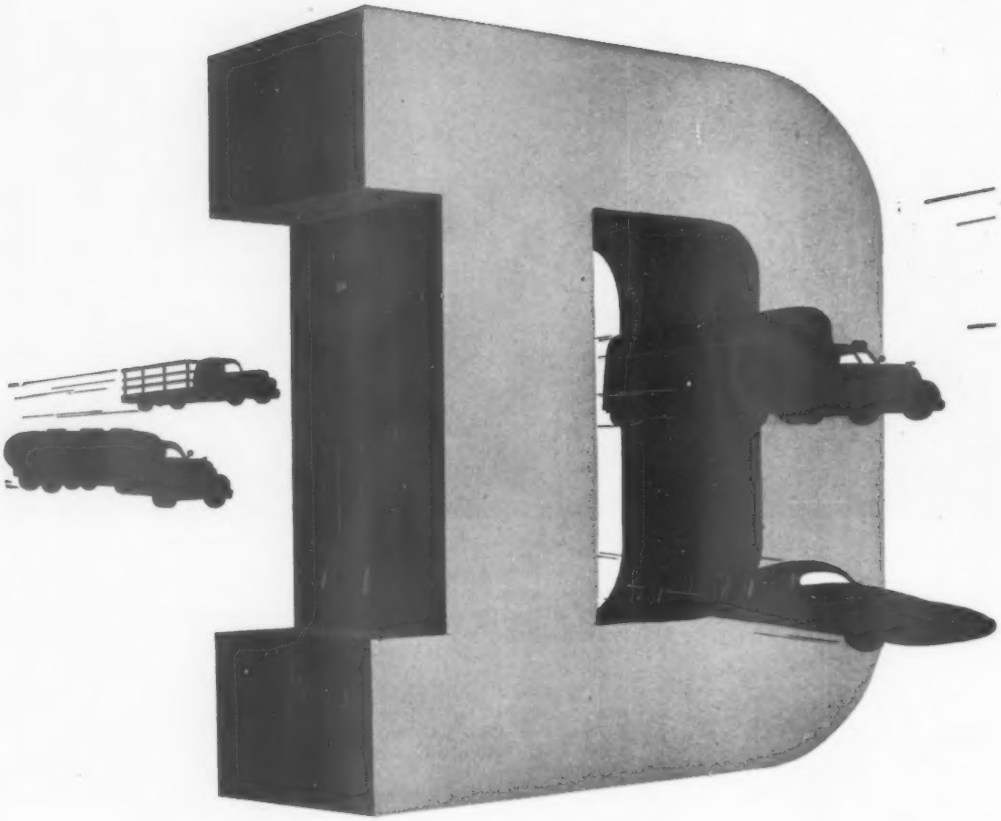
*Farrel-Birmingham* ®



## DAVISON DEPENDABLE CATALYSTS BUILD BETTER MOTOR FUEL

The operating efficiency of synthetic fluid-type cracking catalysts is important. This operating efficiency can be assured by uniformity of physical characteristics and chemical purity. Davison's production of microspheroidal (M-S*) is tops in uniformity . . . providing all users with a highly efficient synthetic fluid-type cracking catalyst. Your requirements can also be supplied in ground (DA-1*) form. Write for further descriptive information. Experienced Davison Field Service Engineers backed up with complete laboratory testing facilities are part of Davison's service.

*T.M.T.D.C.C.

*Progress Through Chemistry*

**THE DAVISON CHEMICAL CORPORATION**

*Baltimore 3, Maryland*

PRODUCERS OF: CATALYSTS, INORGANIC ACIDS, SUPERPHOSPHATES, PHOSPHATE ROCK, SILICA GELS, SILICOFLUORIDES AND FERTILIZERS

# TOOL KIT FOR MICROWAVE

This is it . . . a screwdriver . . . the only tool needed for quick field replacement of Philco microwave units. Philco microwave is the answer to the need for swift, reliable communications. Philco design emphasizes minimum field maintenance time and cost. All major components are "packaged units", quickly and easily replaced on the site with only a screwdriver, permitting convenient depot checkout, for fullest use of field time.

Using JAN (Joint Army-Navy) specification components wherever applicable, Philco microwave is the only equipment available for commercial use with such high standards of quality. Philco microwave gives propagation and equipment reliability unmatched in the field . . . you should investigate.

*For complete information write to Department OG*

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**GOVERNMENT & INDUSTRIAL DIVISION**

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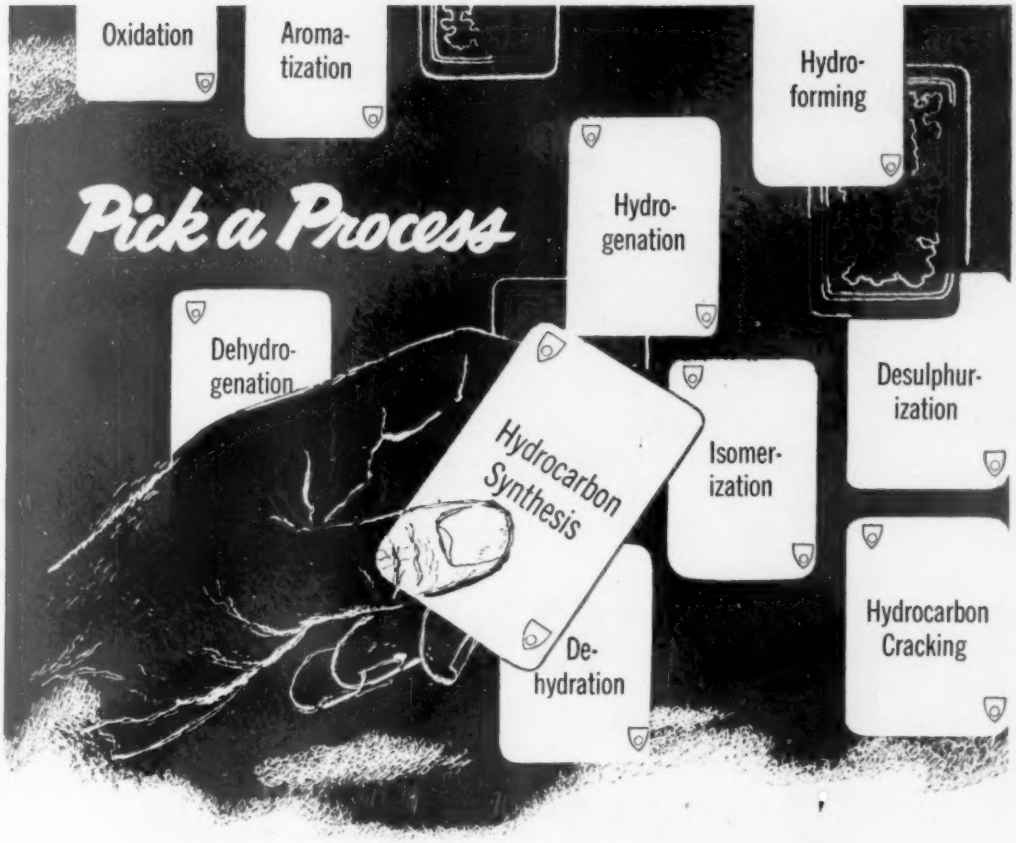



# ALCOA ALUMINA Catalysts

## and Catalyst Supports give **bigger yields . . .** **better quality**

If you want to up-grade your catalytic process yields, or simply reduce losses from contamination and side reactions, you'll find it advantageous to insist on ALCOA Aluminas for your catalysts and catalyst supports.

ALCOA Aluminas—*Activated, Tabular* and *Calcined*—help produce better end products at lower costs because they permit close control over rates of reaction . . . reduce carbon-deposit difficulties . . . often lower operating temperatures.

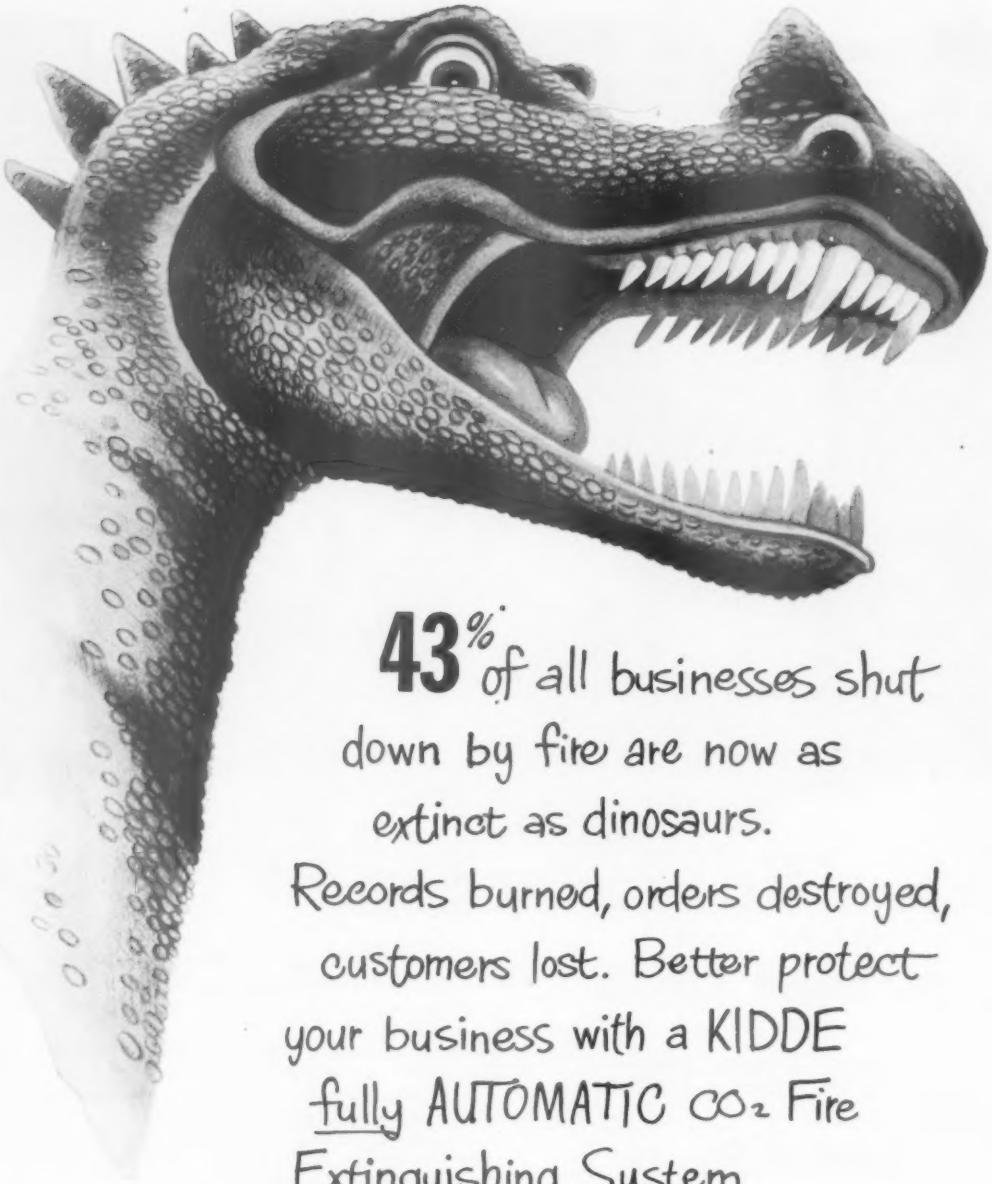
ALCOA Aluminas are uniform in structure and chemical purity . . . stable at elevated temperatures . . . have high resistance to erosion and crushing . . . and are moderate in cost.

Let us send you further information and samples for testing in your own plant. Write to ALUMINUM COMPANY OF AMERICA, CHEMICALS DIVISION, 718-C Alcoa Building, Pittsburgh 19, Pa.

*See our advertisement in Refinery Catalog and Chemical Materials Catalog. For corrosion-resistant heat exchanger tubes, instrument tube, process equipment and architectural items, investigate* ALCOA *Aluminum.*

**Alcoa Chemicals**

ALUMINUM COMPANY OF AMERICA



**43%** of all businesses shut down by fire are now as extinct as dinosaurs. Records burned, orders destroyed, customers lost. Better protect your business with a KIDDE fully AUTOMATIC $CO_2$ Fire Extinguishing System.

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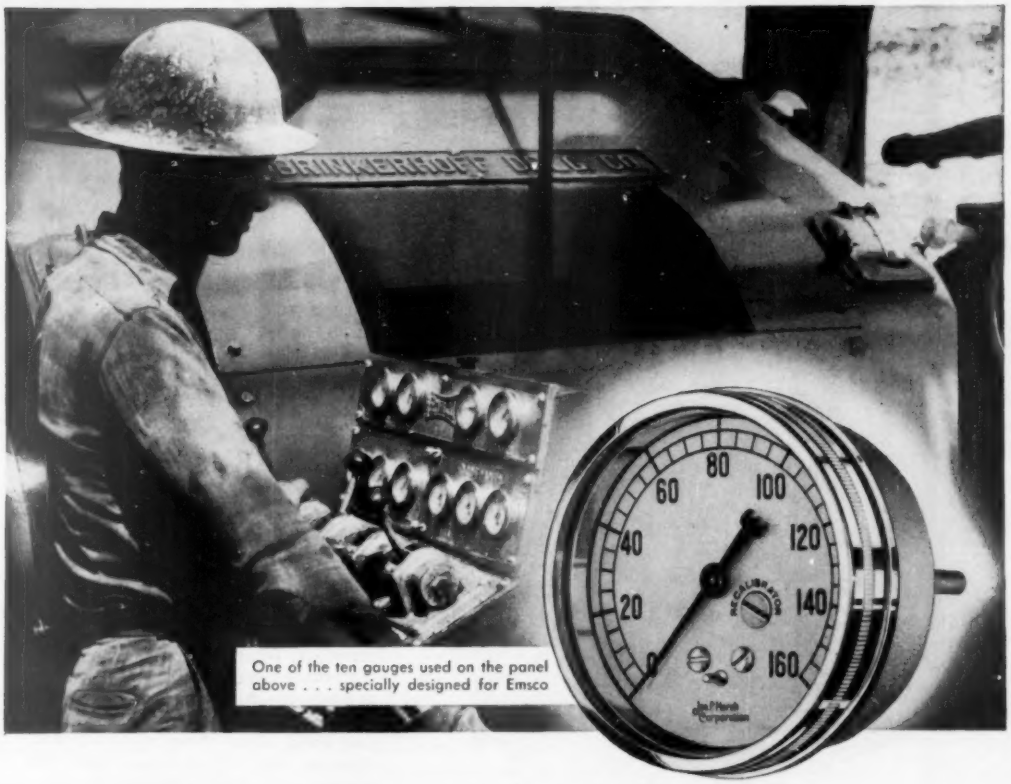


One of the ten gauges used on the panel above . . . specially designed for Emsco

# VITAL JOB FOR GAUGES

## ...only the best can measure up to it

That panel board is the nerve center of the rig . . . and those ten pressure gauges actually guide every move of the operator. This is no place to take chances on instruments of questionable quality; so the manufacturer of the rig—Emsco Derrick & Equipment Co. —has chosen the gauges that have proved worthy of this kind of trust . . . Marsh Gauges.

The choice of Marsh instruments by manufacturers of highest quality equipment in which pressure indication plays a vital part, is a familiar story. And the reason for this preference is equally familiar to everyone who has rubbed elbows with those dependable Marsh Gauges that are doing their job so supremely well wherever oil flows.

Marsh Gauges have been accorded top preference in the petroleum industry because they have set new standards all their own. Ask your supply house for facts or write for bulletins.

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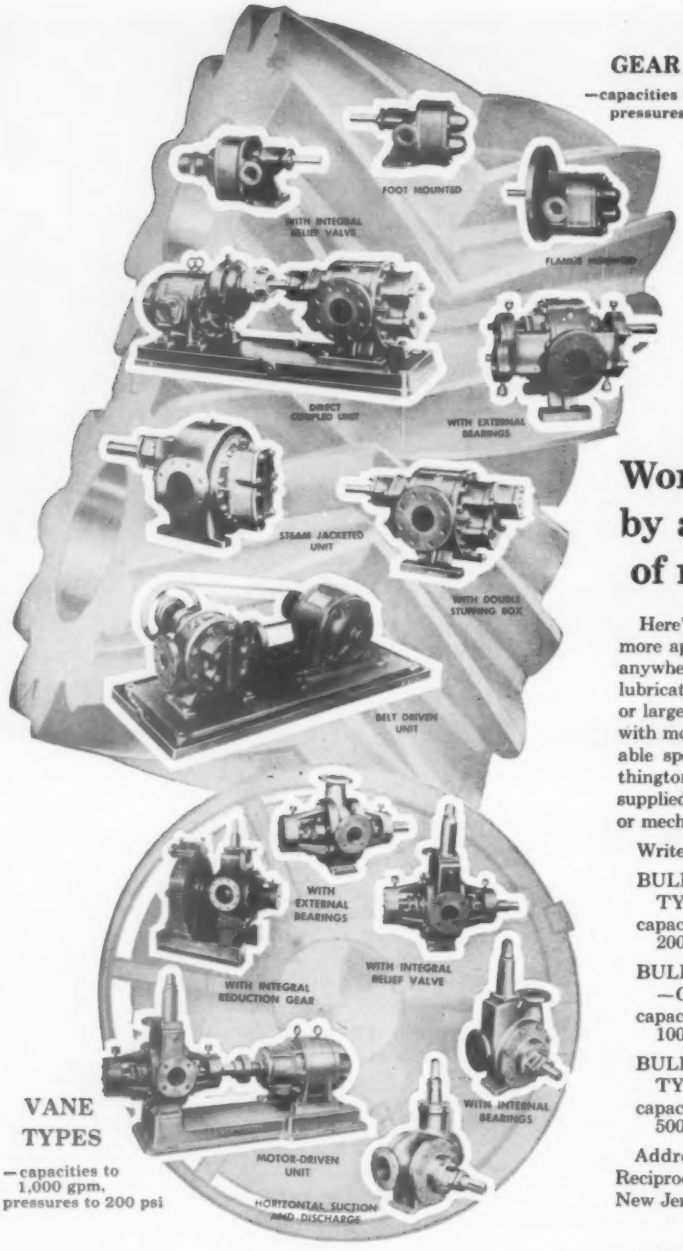
# MARSH GAUGES




**GEAR TYPES**
—capacities to 5,000 gpm, pressures to 500 psi

**VANE TYPES**
—capacities to 1,000 gpm, pressures to 200 psi

# This is what Worthington means by a "complete line" of rotary pumps...

Here's one rotary pump line that covers more applications than any you can find anywhere. Whether you pump thin, non-lubricating liquids or viscous liquids, small or large capacities, low or high pressures, with motor, turbine, engine, belt, or variable speed motor drive, there's a Worthington rotary that'll do your job. Units supplied with either conventional stuffing or mechanical seal.

Write for informative bulletins:

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capacities to 1,000 gpm, pressures to 200 psi

BULLETINS W-484-B1A AND B2—GEAR TYPES
capacities to 56 gpm, pressures to 100 psi

BULLETIN W-487-B10C—GEAR TYPES
capacities to 5,000 gpm, pressures to 500 psi

Address: Worthington Corporation, Reciprocating Pump Division, Harrison, New Jersey.

P.2.4A

The World's Broadest Line Assures You the Right Pump for Every Job

**WORTHINGTON**
Rotary Pumps

# PROCESS EQUIPMENT NEWS

PUBLISHED BY FABRICATED PRODUCTS DIVISION, THE M. W. KELLOGG COMPANY MARCH 1953

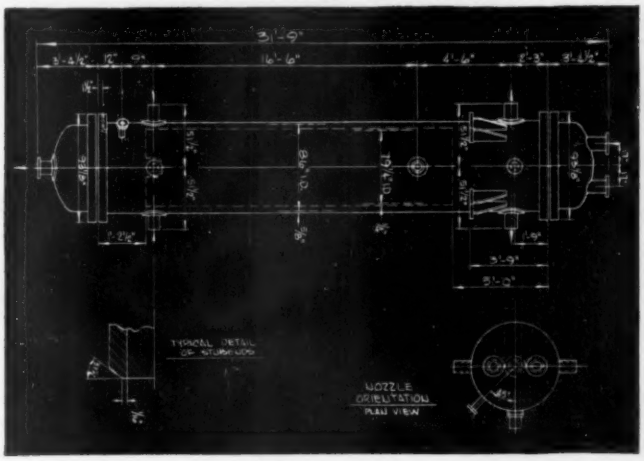
## Special Pre-Heater Monel-Protected Against Caustic

One unusual feature of a special exchanger now in the shops lies in the extensive use of corrosion-resistant Monel® for all parts which might come in contact with caustic soda.

To be installed as a caustic preheater in an eastern seaboard refinery, the unit will have Monel tubes and Monel-*clad* tube sheets. Furthermore, the interior of the channels is protected by a cladding of Monel, while the heads are fabricated from castings of the same high-nickel alloy.

When in service, the exchanger will have 150-pound steam on the shell side which will raise the temperature of the caustic from 155° to 245°F. Twenty inches in diameter, the unit has 16-foot tubes of one-inch by 14-gage Monel. Cladding on the tube sheets is 15% of the overall thickness of the sheet.

® Trademark of the International Nickel Company, Inc.




## Synthetic Fibre Producer Gets Unusual Converters

Most heat transfer devices are designed so that tube bundles can be pulled at regular intervals for cleaning. However, Kellogg has just designed and is now fabricating a set of three synthetic fibre converters which have fixed internals. Special processing conditions, under which materials to be put through the shell side are previously treated, prevents fouling of these sections of the converters. Specification of Stainless Type 340 tubes removes any danger of corrosion in the tube stream and also meets requirements of rather severe operating conditions—650°F and 250 psig. Largest of the three units will measure 23 feet long by 7 feet in diameter and weigh some 23 tons.

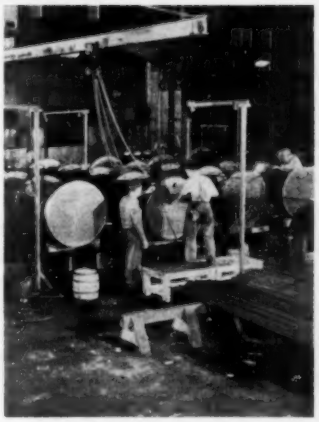
## High Pressure Units for Sumatran Cracker

Six intercondensers for a renovated thermal cracker in Sumatra have just been designed by Kellogg's Fabricated Products Division. Made of alloy steel, they will operate at 1300 psi and 800°F, condensing tower overhead and preheating feed stock. Each condenser will measure 20-feet in length by four-feet in diameter, the shells being 7/16 inches thick.

FABRICATED PRODUCTS DIVISION
THE
M. W. KELLOGG
COMPANY
225 Broadway, New York 7, N. Y.
Offices in Jersey City, Buffalo, Los Angeles, Tulsa, Houston, Toronto, London & Paris
KELLOGG PULLMAN

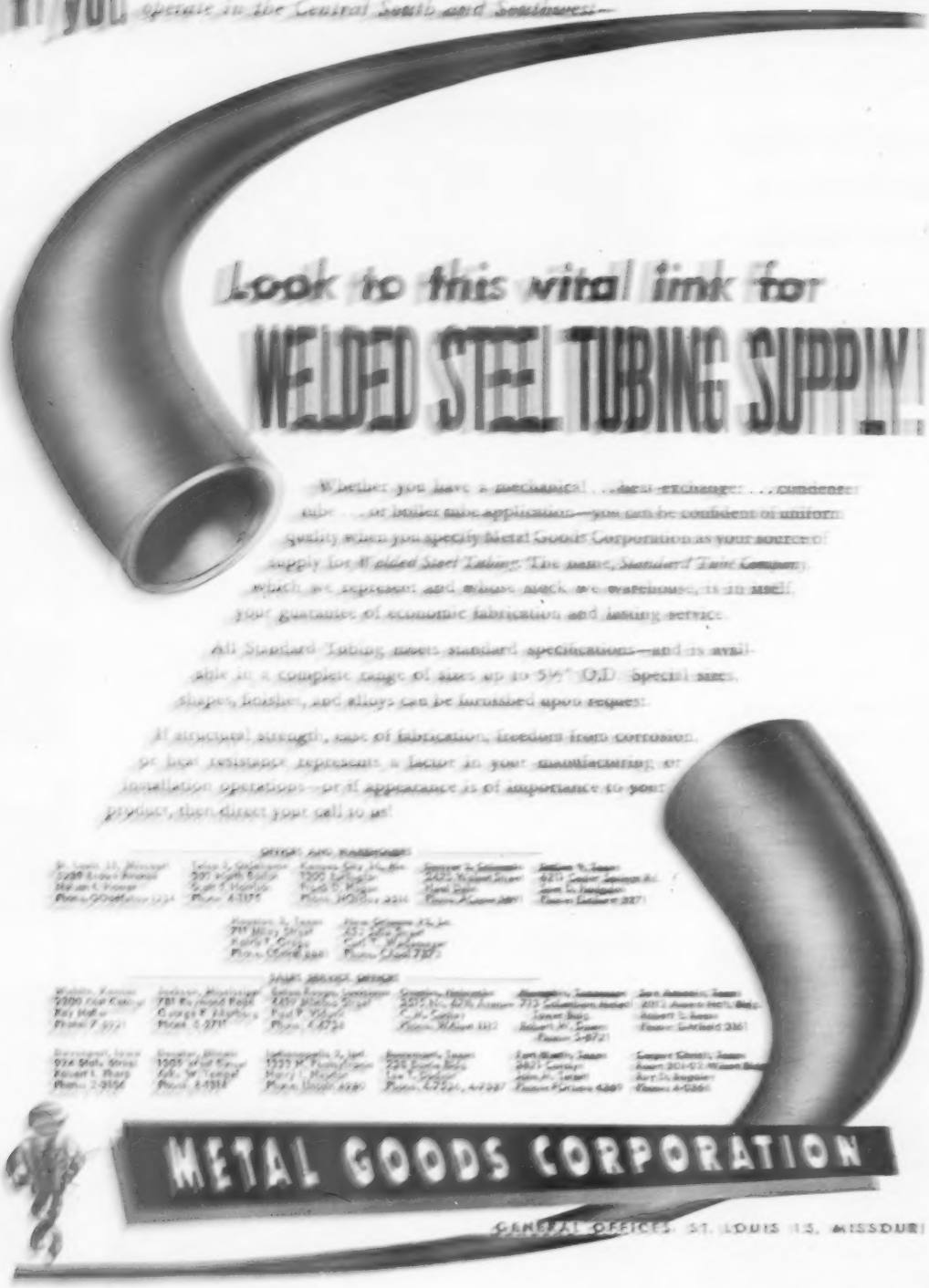
## Exchange Equipment by the Carload for Midwestern Refiner

Exchangers . . . condensers . . . coolers . . . reboilers by the score are in the design and fabrication stages at Kellogg for two locations operated by the same mid-western refiner. Including a multiplicity of varied sizes—ranging from 13 inch-124 sq.ft. debutanizer reboilers to 39 inch-13,000 sq.ft. fractionator overhead condensers—the order includes both equipment for new processing units as well as replacement bundles for existing equipment which is being modernized. This job demonstrates the flexibility of Kellogg fabricating facilities in which orders for one cooler or a hundred AEC exchangers are processed to the highest quality standards.



EXCHANGERS
THIN WALL ALLOY PIPING
CLAD STEEL VESSELS
CONDENSERS
FRACTIONATING TOWERS
PRESSURE PIPING
DIGESTORS
COOLERS

If you operate in the Central South and Southwest—



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Whether you have a mechanical . . . heat exchange . . . condenser tube . . . or boiler tube application—you can be confident of uniform quality when you specify Metal Goods Corporation as your source of supply for *Welded Steel Tubing*. The name, Standard Tank Company, which we represent and whose stock we overhouse, is an added guarantee of economic fabrication and joining service.

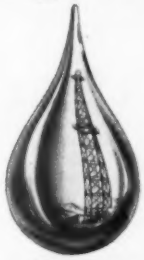
All Standard Tubing meets standard specifications—and is available in a complete range of sizes up to 5½" O.D. Special sizes, shapes, finishes, and alloys can be furnished upon request.

If structural strength, ease of fabrication, freedom from corrosion, or heat resistance represents a factor in your manufacturing or installation operations—or if appearance is of importance to your product, then direct your call to us!

METAL GOODS CORPORATION

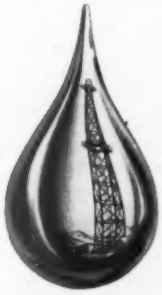
GENERAL OFFICES: ST. LOUIS 15, MISSOURI

# buying caustic soda



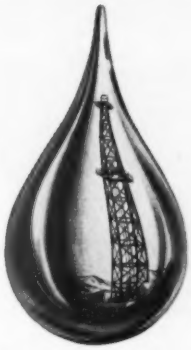
A petroleum refinery expanding production in the Southwest needed a firm source of supply of caustic soda. Requirements ran to several cars a day and, due to limited storage facilities, close scheduling of shipments was essential.

# to better advantage



Like many other petroleum refineries in this area, this plant could be best supplied by Mathieson from production at Lake Charles, Louisiana. Also, only Mathieson could provide the added protection of caustic plants at McIntosh, Huntsville and Anniston, Alabama, and Saltville, Virginia—all within reasonable shipping distance. Mathieson, in addition, is a dependable source of many chemicals essential to refining . . . sulphuric acid, soda ash, ammonia, sulphur, carbonic gas, chlorine, sodium nitrate and sodium chlorite. Moreover, Mathieson often provides an outlet for waste products from the refining process.

# from Mathieson



These same advantages will be of benefit to you. You'll be sure of top-quality chemicals . . . multi-plant production facilities provide dependability . . . integrated delivery system assures on-time schedules. You'll find you can buy chemicals to better advantage—at any time—by consulting with Mathieson.

caustic soda • soda ash • liquid chlorine • sulphur • sulphuric acid • bicarbonate of soda • ammonia • sodium nitrate • nitric acid • hydrazine • sodium methylate • sodium chlorite • hypochlorite products • dry ice and carbonic gas • ammonium sulphate • ethylene derivatives • methanol

MATHIESON

**MATHIESON INDUSTRIAL CHEMICALS COMPANY**
**Division of Mathieson Chemical Corporation**
**Baltimore 3, Maryland**

1616

**If you** *operate in the Central South and Southwest—*

## *Look to this vital link for*

# WELDED STEEL TUBING SUPPLY!

Whether you have a mechanical . . . heat exchanger . . . condenser tube . . . or boiler tube application—you can be confident of uniform quality when you specify Metal Goods Corporation as your source of supply for *Welded Steel Tubing.* The name, *Standard Tube Company,* which we represent and whose stock we warehouse, is in itself, your guarantee of economic fabrication and lasting service.

All Standard Tubing meets standard specifications—and is available in a complete range of sizes up to 5½" O.D. Special sizes, shapes, finishes, and alloys can be furnished upon request.

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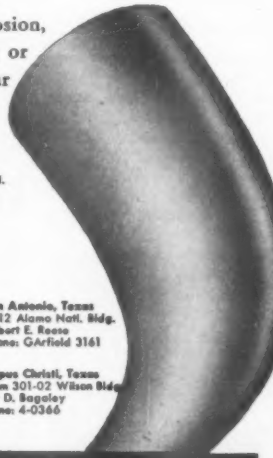

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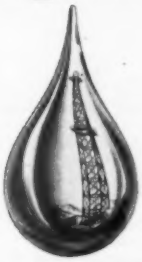
# buying caustic soda



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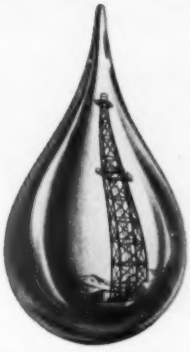

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caustic soda • soda ash • liquid chlorine • sulphur • sulphuric acid • bicarbonate of soda • ammonia • sodium nitrate • nitric acid • hydrazine • sodium methylate • sodium chlorite • hypochlorite products • dry ice and carbonic gas • ammonium sulphate • ethylene derivatives • methanol

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This completely Bonderized® enclosure, more than a match for the severest weather conditions, houses:

1. Life-Linestarter . . . provides dependable control and accurate overload protection.
2. AB Circuit Breaker . . . assures positive, tamper-proof circuit protection.
3. Lightning arrester . . . protects both starter and pumping motor.
4. Time switch . . . converts control to automatic operation for cycle pumping.

This rugged Life-Line motor, power-packed for the toughest jobs, has:

1. Steel frame, bracket and feet . . . withstand the many severe shocks imposed on pumping operations.
2. Pre-lubricated bearings . . . need no further lubrication. Eliminate bearing failure from faulty lubrication.
3. Dynamically balanced rotor . . . assures maximum freedom from vibration. Gives quiet operation.
4. "Pear-shaped" lamination slots . . . allow coils to be slipped in place tightly without forcing. Leave no unfilled spaces to gather dirt.

**WHAT *Life-Line* REALLY DELIVERS IS MORE SERVICE . . . LESS SERVICING**

# Whatever the weather... Wherever the job

## this pair assures pumping efficiency

Weather offers no challenge to the efficiency of Westinghouse Oil Well Pumping Motors and Controls. Specially designed for outdoor pumping service, they shrug off attacks of snow, rain, dust and dirt. Life-Line motors have an outer hood which gives extra weather protection at less cost than totally-enclosed types. And the controls—AB Circuit Breaker and Life-Linestarter—are combined in one rugged, weatherproof, lightning-protected enclosure suitable for pole mounting.

What's more, this protected pair has the stamina to stand up under the demands of continuous pumping duty. They require minimum attention.

The Life-Linestarter provides accurate overload protection. It's advanced in design. Has only one moving element. Nothing to stick or jam. No chance of false operation from vibrations, jars or accidental blows. Where cycle pumping is required, the built-in switch handles the "ON" and "OFF" operations automatically. Means the pumper's periodic trips to the well for manual switching become a thing of the past.

As for the rugged Life-Line motor, it's made to take it! Has steel frame, bracket and feet that can stand the severe service encountered in oil well pumping. Pre-lubricated motor bearings need no lubrication . . . eliminate down time.

Assign this Westinghouse pair to your pumping operation. Gain the dependable service they deliver! Your Westinghouse representative will gladly give you a copy of the "Petroleum Book", B-5444. Or you may write, Westinghouse Electric Corporation, P. O. Box 868, Pittsburgh 30, Pennsylvania. J-21714-A

YOU CAN BE SURE...IF IT'S

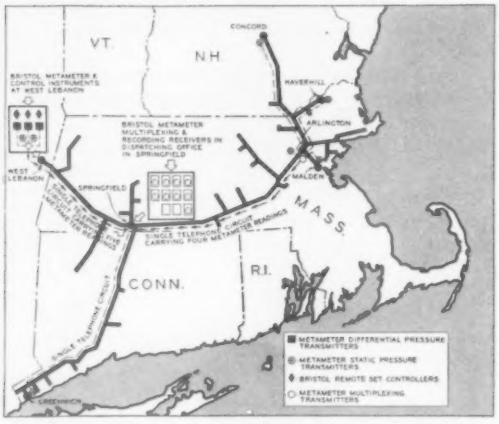
Westinghouse

WHAT'S NEW AT BRISTOL . . . WHAT'S NEW AT BRISTOL . . .

**READINGS OF DIFFERENTIAL PRESSURE** in three meter runs, static pressure, and downstream pressure are made by Bristol Metameter Transmitters at the Northeastern Gas Transmission Company's station at West Lebanon, New York. The readings are multiplexed and sent over a single telephone circuit to Springfield, Massachusetts, over 50 miles away, where they are recorded on separate Metameter receivers.

**NINE BRISTOL METAMETER RECEIVERS** in Northeastern's main office in Springfield record differential, static, and downstream pressure readings sent from West Lebanon, N. Y., and static pressure readings sent from Concord, Haverhill, Malden, and Arlington, Mass. A static pressure reading at Greenwich, Conn., is transmitted over a single telephone circuit to a Metameter receiver at Springfield. Flow through meter runs at West Lebanon is controlled by Bristol Differential Controllers remotely set at the Springfield office.

# METAMETER® MULTIPLEXING TELEMETERS




**MAP SHOWING** Bristol Metameter MULTIPLEXING Telemeters on Northeastern Gas Transmission Co.'s pipeline.

## BRISTOL takes another big step forward in telemetering

Bristol Metameter Telemeters have proven their value and dependability on thousands of installations. They are used by gas, electric, water and steam utilities, gas and oil pipe lines, and industrial plants the world over. Now, the development of the Metameter MULTIPLEXING Telemeter marks a new step forward in telemetering progress.

It is now possible, with the Metameter MULTIPLEXING Telemeter, to transmit up to 15 remote readings over a single circuit! It is no longer necessary to take up a circuit for each transmitter-receiver pair. Of course, this means a tremendous saving in circuit costs.

For every application of remote measurement and automatic control—pressure, vacuum, liquid level, flow, temperature, static and differential pressure, motion, voltage, current, power and totalized load—think of Bristol Metameter Telemeters. Write to The Bristol Company, 120 Bristol Road, Waterbury, Connecticut. 39

# BRISTOL

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## for your toughest heat exchange problems

CUPRO NICKEL, 30%-702, is the best and most widely used copper alloy for tubes in refinery heat exchangers operating under the severest conditions—where corrosive materials and cooling waters must be handled at relatively high temperatures and pressures.

In refinery heat exchanger equipment, tubes of Cupro Nickel, 30%-702, retain strength at relatively high operating temperatures and are resistant to stress-corrosion cracking. The alloy has the property of forming protective films of corrosion products, making it particularly desirable for service where sea water, even at relatively high velocities, is used for cooling.

Our Technical Department will welcome the opportunity to investigate your heat exchanger tube problem and to draw upon its long experience in tube performance to suggest the most suitable alloy. Feel free to use this service. Use the coupon below for your copy of Publication B-2, "ANACONDA Tubes and Plates for Condenser and Heat Exchangers." AD114

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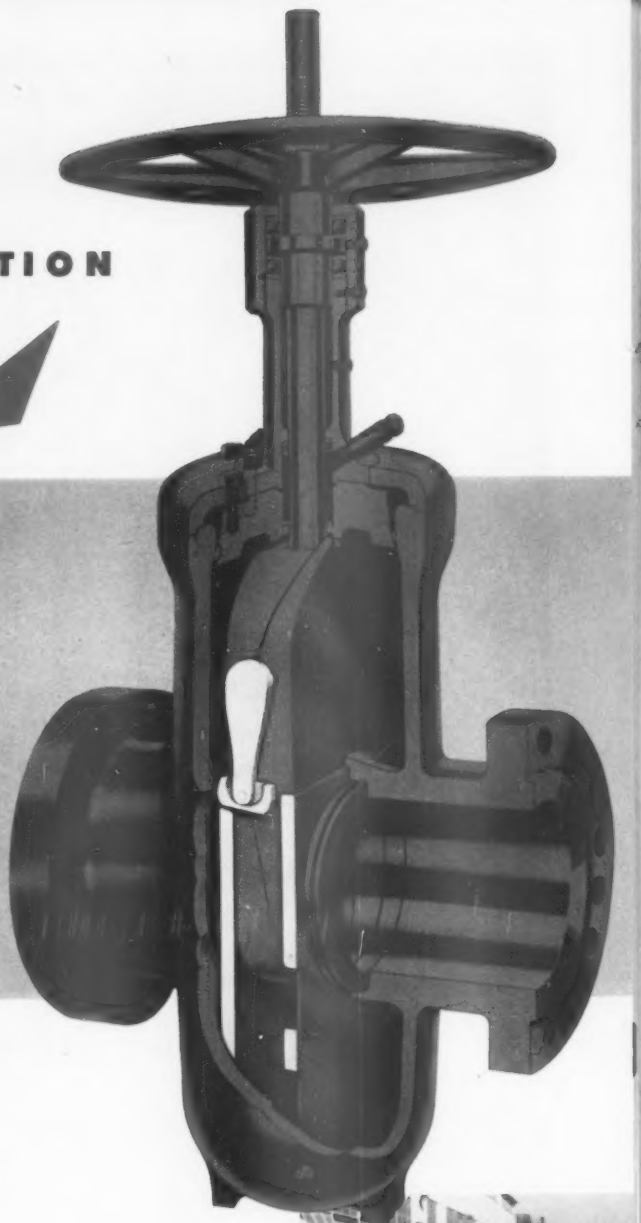
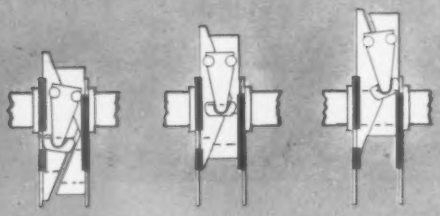
# EXCLUSIVE LEVERLOCK ASSURES POSITIVE OPERATION in W-K-M VALVES



Leverlock action guarantees that W-K-M Valves always open and close efficiently. It controls neutral position of the gate and segment while opening or closing the valve . . . permits expansion of gate assembly ***only*** at proper time for seating in opened or closed position . . . assures positive controlled gate and segment pressure against ***both*** the upstream and downstream seats.

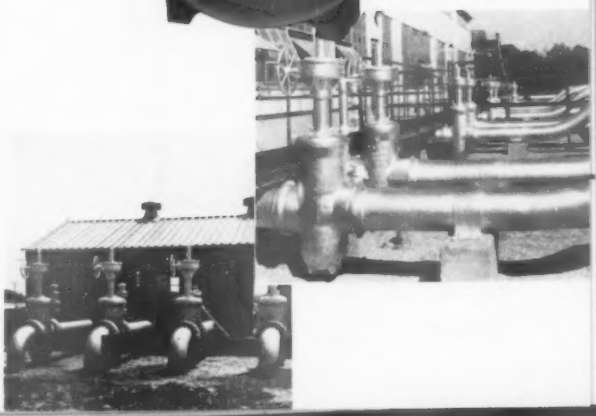


Gate and segment in closed position. | Neutral position. | Completely open.

The basic W-K-M Through Conduit Design and expanding gate have proved unequalled in the most severe tests. These, combined with Leverlock operation, no surge operation, simple maintenance, quick overhaul in the field, make W-K-M Pipeline Valves top standard for the industry. When you want dependable valve performance, specify W-K-M Valves all the way.

W-K-M COMPANY
P. O. Box 2117 Houston 1, Texas
727 W. Seventh St., Los Angeles, Calif.
Export Office: 30 Rockefeller Plaza, New York, N. Y.

W-K-M Valves



Kean Archives

# IMPORTANT DATES IN HISTORY

June 17, 1775 — date of one of the crucial battles in modern history — the Battle of Bunker Hill. The British achieved an immediate advantage by gaining possession of a strategic point. The Americans lost a quarter of their men, the British over one-third.

On the American side this vital fight served to uplift even higher their moral spirit and unflagging determination to win the final outcome.

This rugged "stick-to-it-ness" and pioneer spirit still prevails today. It is the underlying reason why American business continues to make more and better products that last longer and work more efficiently.

Wheatland steel pipe carries the date of its production welded into each length. Behind this important date stands an organization of specialists, whose job it is to produce this one product, only steel pipe. Ask for Wheatland, "the pipe with the year mark".

**WHEATLAND TUBE COMPANY**

BANKERS SECURITIES BUILDING, PHILADELPHIA 7, PA.

"PIPE WITH THE YEARMARK"

Scrap is urgently needed to help keep America strong and free. Do your part — get in your scrap today!

REPUBLIC
INSTRUMENTS
AND CONTROLS

# *Do You Know About ALL of the* **REPUBLIC** *Line?*

Check the Republic line of measurement and control equipment listed below. You'll find instruments and controls to meet your needs—whether for a simple control or an automatic control system. And teamed with this equipment is an experienced engineering staff which can give you the right answer to your measurement and control problems.

☐ **ELECTRICAL FLOW METERS.** For metering the flow of steam, water, gas, air, oil, brine, etc. The reading instruments, indicator, recorder and integrator, are remote reading and can be supplied singly or in any combination desired. Integration is continuous, an exclusive Republic feature.

☐ **PNEUMATIC TRANSMITTERS.** For converting process variables such as flow, liquid level, pressure, or liquid density into air pressures which vary proportionally with the process variables. These air pressures can be used as a measuring impulse for the actuation of an automatic controller or a direct reading recorder.

☐ **$CO_2$ METERS.** Provide a continuous record of percent $CO_2$ in flue gas measured by the Orsat method. Furnished with either mechanical or electrically actuated remote reading indicator and recorder.

☐ **DRAFT INSTRUMENTS.** Indicating or recording types in single or multiple units. Furnished in all standard ranges of draft and pressure.

☐ **THERMOMETERS.** A long distance, gas filled thermometer with either single or multiple pen recorder.

☐ **LIQUID LEVEL INSTRUMENTS.** Remote reading indicators and recorders. Also provided with various types of alarm devices.

☐ **MULTI-POINT INDICATORS.** Will indicate, on separate vertical scales from two to sixteen units of draft, pressure, flow, temperature, $CO_2$, etc., in any combination desired.

☐ **MULTIPLE RECORDERS.** Strip Chart Type will record from three to six separate records of flow, temperature, $CO_2$, pressure, etc., in any combination desired. Round Chart Type can have up to 4 pens.

☐ **REGULATORS.** For the automatic control of pressure, draft, rate of flow, rate of fuel feed, speed of rotation, liquid level, etc. For proportioning two pressures or flows. Regulators may be either air or oil operated. Flexibility in design and construction allows the regulator to perform any type of control action. Setting may be remote or manual.

☐ **AUXILIARY RELAYS.** Multiplying, dividing, adding, subtracting, maximum and minimum setting, ratio, ratio computing, sequential, splitter, squaring, square root extracting, and position indicating.

☐ **COMBUSTION CONTROLS.** A centralized, automatic system for controlling steam pressure, combustion, furnace pressure, excess pressure, boiler level, etc. Automatically regulates the fuel and air input to a boiler in measured proportions and in a fixed ratio for the entire load range. Adaptable to multi-fuel firing.

☐ **DESUPERHEATERS.** Atomizing type desuperheater uses a small quantity of high pressure steam to vaporize an automatically controlled amount of water in reducing steam temperature to the desired degree.

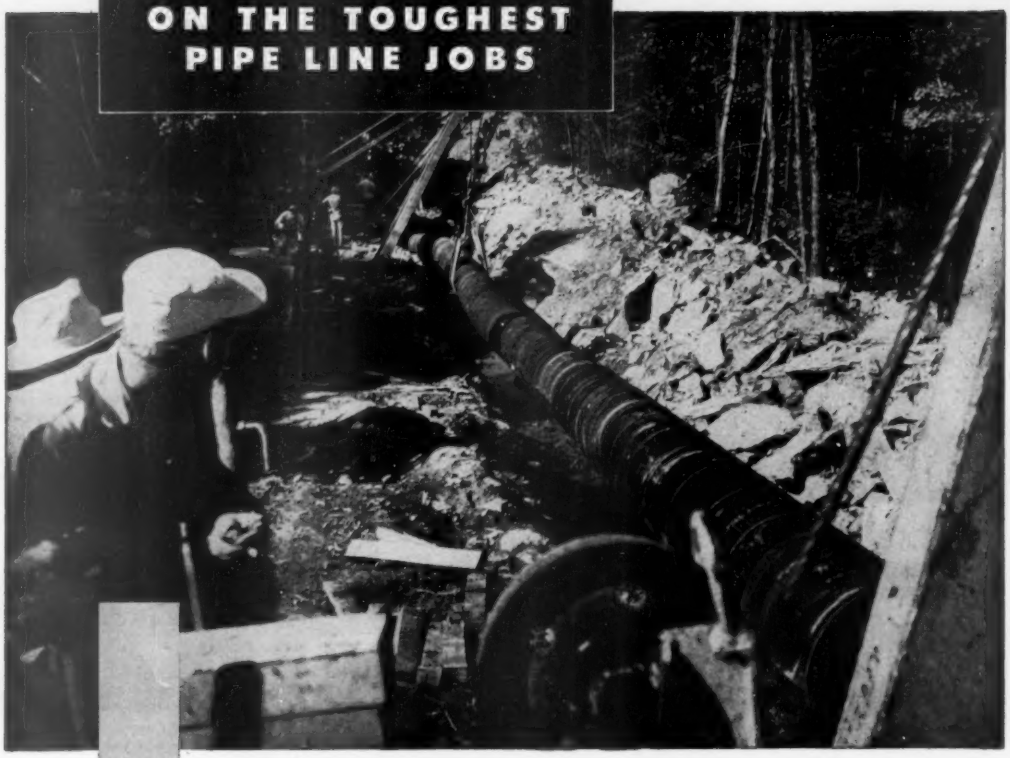
☐ **VALVES—REGULATING AND PRESSURE REDUCING.** Designed and built for all practicable ranges of pressures with either flanged or welded ends. Special body design sharply reduces erosion and noise. Cylinder operated valves available in sizes from 3 in. to 24 in. Hand operated valves in sizes from 1 in. to 8 in. Lever operated valves in sizes up to 16 in. Republic valves are built in accordance with A.S.A. Standards for all pressures up to 2500 psi. Diaphragm operated valves are available for pressures from 125 to 1500 psi and from 3 in. to 10 in. in size. Special purpose alloy steel butterfly valves in sizes 4 in. to 24 in. are also available.

***Data Books are available on any of the above equipment***

**REPUBLIC FLOW METERS CO.**

**2240 Diversey Parkway • Chicago 47, Illinois**

ON THE TOUGHEST PIPE LINE JOBS



## Claymont Welded Steel Pipe Fits Up Faster—Lowers In Easier

Claymont pipe is made from high-tensile steel plates produced entirely in our own plants and quality-controlled through every phase of fabrication starting with the open hearth. Every length is hydraulically expanded for accurate size and perfect roundness...precision bevelled at the ends for time-saving, labor-saving ease of handling in the field.

Available in lengths of 40 feet and in overall diameters from 24 inches through 36 inches. Write to Wickwire Spencer Steel Division, Claymont Plant, Claymont, Delaware or our nearest sales office.

FLANGED AND DISHED HEADS...CARBON, ALLOY AND STAINLESS-CLAD STEEL PLATES
LARGE DIAMETER STEEL PIPE
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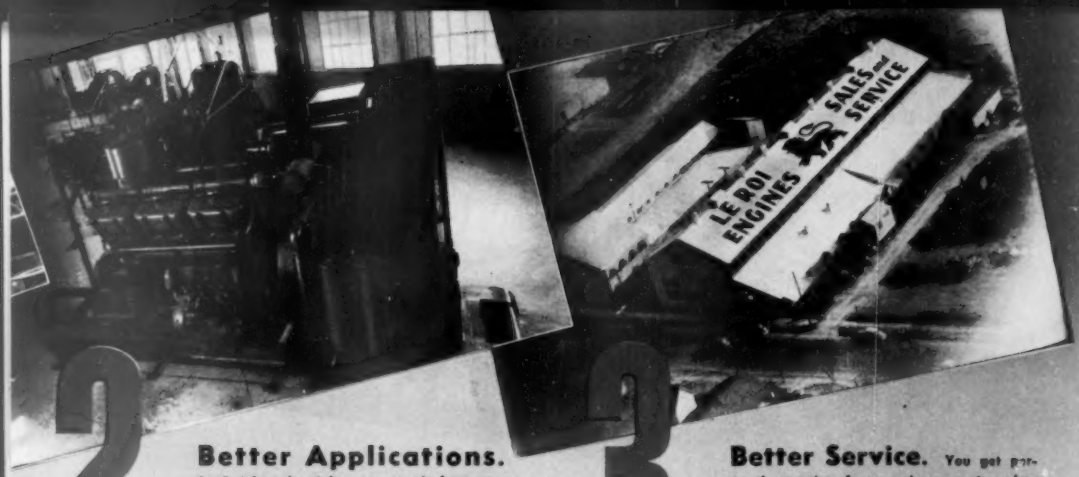
CLAYMONT
WELDED STEEL PIPE
PRODUCT OF WICKWIRE SPENCER STEEL DIVISION
THE COLORADO FUEL AND IRON CORPORATION

# Le Roi 3 way Partnership

**1. Better Engines.** As one driller near Dennison, Texas puts it, "We never had any power unit like our Le Roi H540 for power and acceleration." The H540 is Le Roi's compact 155 HP V-8, one of three all-new designs brought out to provide better engines for the oil fields.

# 13,300′ in 122




**2. Better Applications.** Le Roi has the right power unit for every application. For example, at this pipeline station, a Le Roi RXISV has operated 35,000 hours without major repairs. Le Roi distributors and field men know how to apply engines to get maximum economy and dependability.

**3. Better Service.** You get personal attention from engine experts, when you deal with exclusive Le Roi distributors. They handle only Le Roi — so keeping your Le Roi engines running is their sole responsibility. Large parts-stocks and skilled mechanics mean prompt service and a minimum of downtime.

# days! { with only two Le Roi L 3000'S

Hall-Stewart's two-engine Le Roi L3000 rig has more than the 1950 drilling-depth record in West Texas to its credit. The Midland, Texas drilling contractor says this about his Le Roi's:

*"We're now drilling our sixth 13,000-foot well. That's hard work on any engine, but we think our Le Roi's are 'just getting broken in'.*

*"We find that Le Roi L3000's are faster on acceleration — and have more pep — than slower, in-line engines.*

*"Ever since we've had our first Le Roi engine, service from General Machine & Supply Co. (West Texas Le Roi distributor) has been excellent. Their overhaul work is superior to any other shop. And they get a man out faster, when we need him.*

*"Repairs cost less, too. We figure 25% less for overhaul than with other engines."*

Le Roi drilling engines range from 155 to 600 max. hp. They operate on abundant, low-cost oil-field fuels — natural gas or butane — and can be switched from one to another in an instant.

On original equipment or as replacement engines, Le Roi power puts you ahead of the field. Contact your nearby distributor or Le Roi Oil Field Headquarters for details of Le Roi's 3-way Partnership.

## LE ROI COMPANY

**MILWAUKEE 14, WISCONSIN**
*Plants:* Milwaukee • Cleveland • Greenwich, Ohio
*Oil Field Headquarters:* Tulsa, Oklahoma

### See these Le Roi Distributors for a Profitable 3-way Partnership or contact your favorite supply house

**Oklahoma**
Le Roi Company Branch — Tulsa
Carson Machine & Supply Co.— Oklahoma City

**East & South Texas, Gulf Coast**
Southern Engine and Pump Company — Houston, Kilgore, Edinburg, Dallas, San Antonio, Corpus Christi, Texas, and Lafayette, Houma, Louisiana.

**North & West Texas, New Mexico**
General Machine & Supply Co. — Odessa, Snyder, Texas.
Nortex Engine & Equipment Co.—Wichita Falls, Texas.

**Kansas**
Carson Machine and Supply Co.—Great Bend

**Illinois — Western Kentucky**
Western Machinery & Engine Company — Centralia, Illinois and St. Louis, Missouri.

**Michigan**
Hafer Engine Service — Reed City

**Rocky Mountain Area**
Gehring Equipment Co. — Casper, Wyoming, Rangeley, Col.

**Mississippi, Arkansas and Northern Louisiana**
Ingersoll Corporation — Shreveport, Louisiana, Jackson, Mississippi, El Dorado, Arkansas

**West Coast**
Le Roi-Rix Machinery Co. — Los Angeles, Long Beach and Bakersfield, Calif.

**Appalachian Area**
P. C. McKenzie Co., Pittsburgh, Bradford.

**Canada**
Lucey Export Ltd. — Calgary, Edmonton, Alberta.

P-113

### A Typical Le Roi Service Facility

Here's the efficient well-arranged parts department of the Le Roi-Rix Co.'s Long Beach branch. Two more offices—at Bakersfield and Los Angeles—are similarly equipped. All three offices maintain prompt 24-hour service. Le Roi has service facilities like these throughout the oil fields — another reason why you can depend on Le Roi.

# If CORROSION is a problem...

## HOMESTEAD *Lever-Seald* VALVES

## WILL *SOLVE* IT!

In leading chemical plants, refineries, paper mills, textile plants, steel mills and hundreds of other industries HOMESTEAD Lever-Seald Valves have virtually put an end to valve operating problems. Corrosive or viscous fluids, extremes of temperature or pressure or other adverse conditions that cause ordinary valves to stick or seize, simply cannot affect HOMESTEAD Lever-Seald VALVES. For built into each valve is a powerful lever-and-screw device that prevents sticking and assures positive action at all times, under all conditions in services ranging from 40° below zero to 1100° Fahrenheit.

HOMESTEAD Lever-Seald VALVES are available in straight-way, three-way, and four-way types, with screwed or flanged connections, in Semi-Steel, Steel, Ni-Resist, Stainless Steel, Monel or other alloys from 1″ to 12″, for vacuum to 1500 lbs. They are also furnished for pressure gun lubrication if desired.

If Corrosion . . . Temperature . . . Pressure . . . or fluid contamination is a problem, why not solve it by changing to HOMESTEAD Lever-Seald VALVES today.

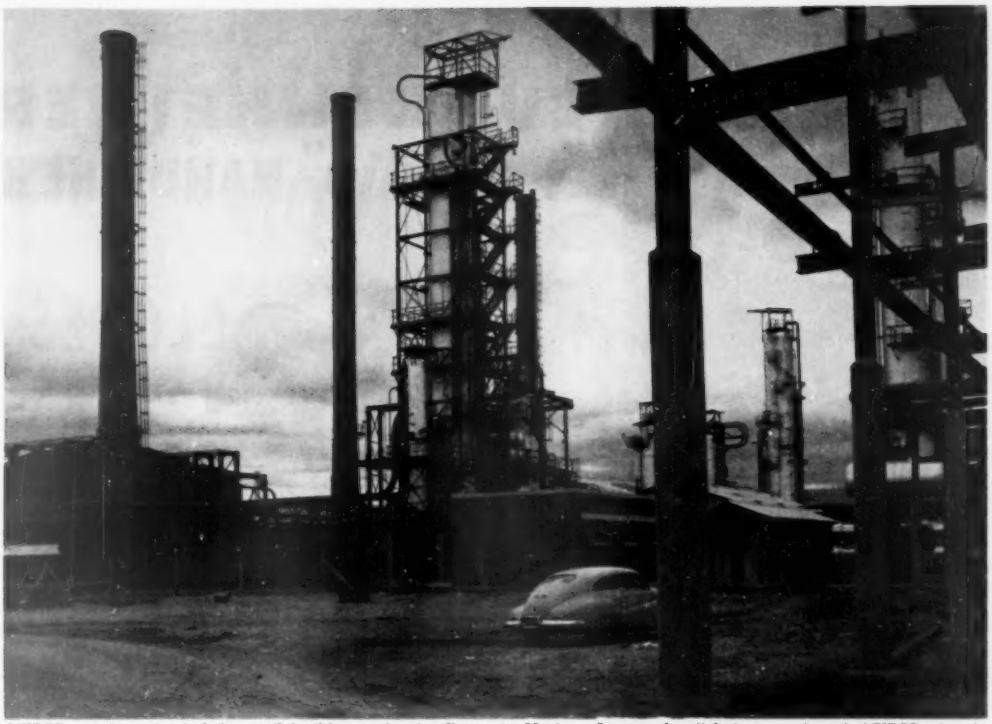
*Valve Reference Book No. 39 on Request.*

**HOMESTEAD VALVE MANUFACTURING CO.**

"Serving Since 1892"

CORAOPOLIS, PA.

P. O. BOX 403



ACIPCO cast iron pipe is being used in this prominent refinery in Mexico. Long and satisfactory service of ACIPCO pipe in installations throughout the United States and many foreign countries is indicative, not only of the quality of ACIPCO products, but also of the experience of the ACIPCO organization in cooperating on piping problems.

# ACIPCO Pipe Serves Oil And Gas Industries

ACIPCO produces a complete line of high quality cast iron pipe for the oil and gas industries. ACIPCO pipe is conveying gas, crude oil, gasoline, sour naphtha, salt brine, sewage, Foamite fire foam, water—and in fact, just about everything that a pipe line can conceivably convey. It is conveying these products under operating pressures ranging from a few pounds to the square inch, up to pressures in excess of 100 pounds of gas and 500 pounds liquid.

Our pipe is manufactured by the Mono-Cast centrifugal process, under rigid specifications in diameters 3-inch through 48-inch. It will stand the impact of heavy loads and gives complete job satisfaction. The pipe is made in specific weights for specific laying conditions. You get the exact pipe your conditions require.

It is equipped with any of a wide variety of joints including American Double-X, Flanged, Screw-Gland, Molox Ball Joint, Roll-On Joint, and Bell and Spigot. A complete line of fittings is available including transition pieces for interconnecting with other types of joints and pipe.

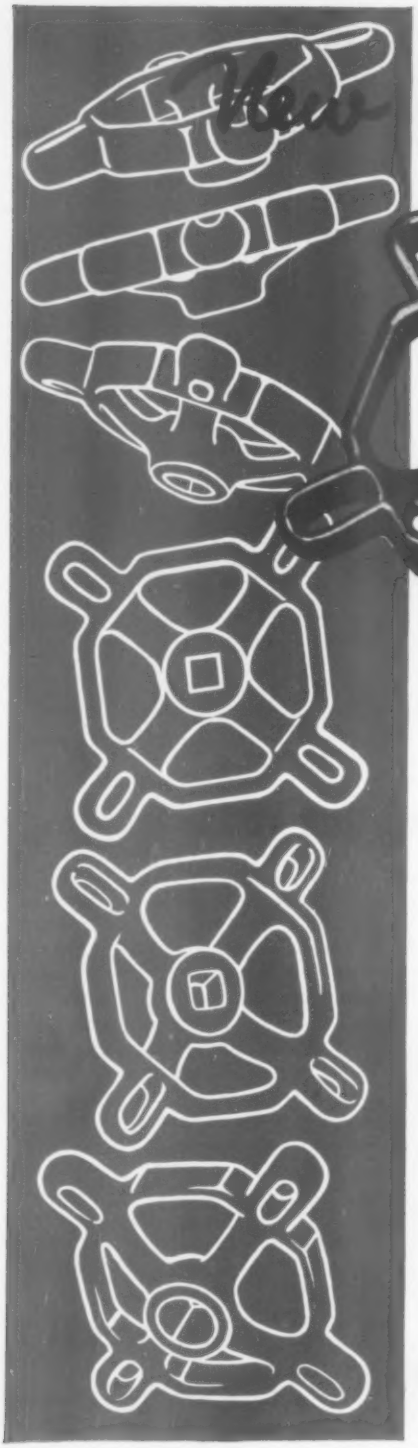
As America's largest individual cast iron pipe foundry, ACIPCO offers unexcelled foundry facilities and a highly trained and experienced organization for the production of highest quality cast iron pipe and fittings for oil and gas transmission and distribution, condenser coils, refinery and other process piping.

Branch stocks of both pipe and fittings are strategically located in various cities for your convenience. Write the office nearest you. Free literature will be sent on request.

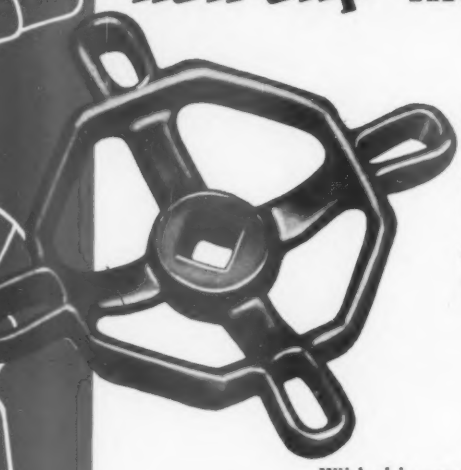
## AMERICAN CAST IRON PIPE COMPANY

**BIRMINGHAM 2, ALABAMA**

Minneapolis · Houston · San Francisco · Pittsburgh · Kansas City · New York City
Chicago · Dallas · Cleveland · Los Angeles · El Paso · Seattle · Denver



# LUNKENHEIMER "non-slip" HANDWHEEL



## CLOSES VALVES TIGHT!

With this revolutionary new handwheel design, *ordinary hand pressure closes the valve absolutely tight, thus preventing leakage.*

Rounded lugs provide a firm, comfortable, secure grip, even when the operator's hand is wet or greasy. And the "Non-Slip" Handwheel stays cool —does not transmit excessive heat to the outer rim. Operator's hand cannot touch the top of the valve stem, which may be hot.

Only Lunkenheimer Valves have the new malleable iron "Non-Slip" Handwheel. Ask for a demonstration of its amazing performance. Hear how it will save you money by eliminating one of the most common causes of valve leakage.

WRITE FOR new bulletin describing the advanced "Non-Slip" Handwheel and demonstrating its outstanding features. The Lunkenheimer Company, Box 360F, Cincinnati 14, Ohio.

BRONZE • IRON • STEEL

**LUNKENHEIMER**

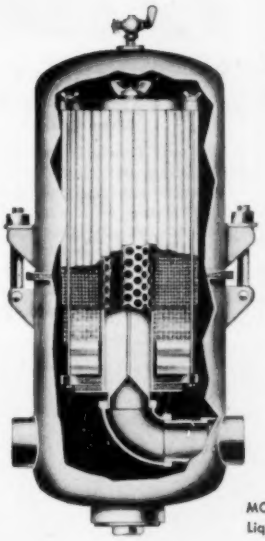
THE ONE *Great* NAME IN VALVES

L-752-5

# STAYNEW LIQUID FILTERS

## PROVIDE DEPENDABLE DAY IN DAY OUT PERFORMANCE

PRACTICALLY any liquid can be efficiently and economically filtered by a Staynew Liquid Filter. They are designed for adaptation to virtually any space requirement or any arrangement of inlet and outlet connections. All known types of filtering media are available to provide any degree of efficiency for any specific problem, or for use regardless of temperature, pressure or corrosion requirement. All units can be constructed according to the API-ASME and the various ASME Code specifications. Staynew Model ELS liquid filters are available in many types of materials other than regular steel, such as stainless steel, monel, herculoy and other non-corrosive materials.



MODEL ELS
Liquid Filter

### PARTIAL LIST OF LIQUIDS THAT CAN BE FILTERED BY STAYNEW LIQUID FILTERS

Acetone
Acids
Adhesives
Alcohols
Alkalis
Ammonia
Asphalt
Benzene
Benzine
Beverages
Butane
Casein
Castor Oil
Caustic
Cellulose Solutions
Chlorine
Chocolate
Cleaning Fluids
Coating
Coolants
Cutting Oils
Emulsions
Enamels
Ethanolamine
Ethylamine
Extracts
Flameproofing Solutions
Fuel Oil
Furniture Polish
Gasoline
Glue
Greases
Gums
Hydraulic Fluids
Ink
Kerosene
Lacquers
Latex
Liquid Paraffin
Lubricants
Molasses
Naphtha
Paint
Pharmaceuticals
Propylene
Quenching Oils
Resins
Rubber Cements
Sizing
Soap
Solvents
Steam Condensate
Syrups
Tar
Turpentine
Varnish
Vegetable Oils
Viscose
Water
Wax

**SEND** for this 12-page bulletin D-IL containing specifications, engineering and performance data, photos and descriptions of recommended types of filter media, check list of liquids that can be filtered and other helpful data.

DOLLINGER PROTECTOMOTOR STAYNEW FILTERS

*Representatives in Principal Cities*

**DOLLINGER CORPORATION**

5 Centre Pk., Rochester 3, N. Y.

ALL TYPES OF FILTERS FOR EVERY INDUSTRIAL NEED

# It's New...It's Flexible...

**STRATOLINE...**

***The Most Streamlined Coupling Ever Made***

The new Hewitt-Robins Stratoline Coupling embodies the *strongest, smoothest construction by far ever used on any rotary drilling hose.* This new coupling, with API line pipe threads, is no bigger in diameter than the hose itself—has no protruding parts—is absolutely snag-proof, leakproof, easier to use, saves handling time.

HEWITT-ROBINS INCORPORATED

## HEWITT-ROBINS

DIVISIONS: HEWITT RUBBER • ROBINS CONVEYORS • ROBINS ENGINEERS • RESTFOAM®

# It's Stronger...It's Safer

***The New Hewitt-Robins Cable-Reinforced Rotary Drilling Hose with the Exclusive Streamlined Stratoline Coupling and Built-in Safety Eye***

Feature for feature, the new Hewitt-Robins Cable-Reinforced Rotary Drilling Hose with the exclusive Stratoline Coupling meets the most exacting requirements. This new rotary drilling hose is unequalled for safe, dependable, long-life performance and handling ease on any type of rotary drilling rig.

## ENGINEERING DATA

**CONSTRUCTION:**
High-tensile airplane cable wire spiraled on, right hand and left hand to equalize tension and control elongation. Third cable coiled on to eliminate dancing and shimmying . . . Has strength to match highest operating pressures—flexibility to drape smoothly on any type of rig.

**TUBE:**
Neoprene-base synthetic compound meets all current operating requirements, including high mud temperatures, oil-based mud and oil emulsions.

**COVER:**
Neoprene-base synthetic compound—resists oil, sun-checking, strain crack, cutting abrasion, weather and temperature extremes. Black with longitudinal yellow stripe to ease alignment.

**SAFETY EYE:**
Permanently fused to hose body 29" from threaded end of coupling at each end of hose for attaching safety chain to derrick and swivel—eliminates need for external clamps.

**CHECK FOR INFORMATION ABOUT THESE JOB-TESTED HEWITT-ROBINS HOSES FOR YOUR OPERATION, OR CALL YOUR HEWITT RUBBER DISTRIBUTOR**

*(See "Rubber Products" Classified phone book)*

- *☐ ROTARY DRILLING HOSE
- ☐ FLEXIBLE VIBRATOR HOSE
- ☐ MUD PUMP SUCTION HOSE
- ☐ WATER SUCTION HOSE
- ☐ WATER WASHDOWN HOSE
- ☐ STEAM HOSE
- ☐ SERVALL® (All Purpose)
- ☐ TWIN-WELD®

**Now available at these distributors:*

THE BETHLEHEM SUPPLY COMPANY OF CALIFORNIA
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# INCORPORATED

EXECUTIVE OFFICES: STAMFORD, CONNECTICUT

**Wagner**
**ELECTRIC MOTORS**
**... the choice of leaders in industry**

## OIL WELL PUMPING MOTORS

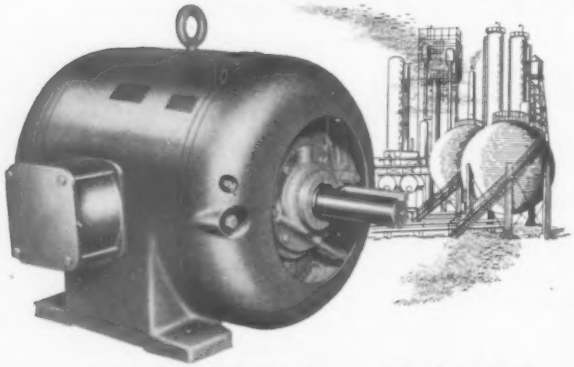
**... POLYPHASE, SINGLE-PHASE**

These cast-iron frame motors, especially designed for outdoor service, have double-end ventilation. Baffles inside the end-plates direct a cooling air flow around the stator iron and windings, while retarding the entrance of water. Motor windings are specially treated for outdoor service and the conduit box is moisture-proof and dust tight. These motors are available in ratings through 75 hp and are built in two electrical types: high torque, normal slip; and high torque, high slip.

# Wagner MOTORS

*time-tested favorites of the oil fields*

**in the field ... in the refinery**



## EXPLOSION-PROOF MOTORS

These polyphase motors have been approved by Underwriters' Laboratories for Class I Group D hazardous locations. They feature housings strong enough to withstand explosion inside the motor, machined fits long enough to prevent the escape of flames to the surrounding atmosphere, and heat capacity great enough (even under abnormal operating conditions) to prevent the motor from reaching a temperature which would ignite surrounding gases. These totally-enclosed fan-cooled motors are available in ratings through 250 hp, with a choice of cast-iron frame or steel frame construction.

For locations where only single-phase current is available, Wagner can furnish capacitor-type oil well pumping motors.

Write for Bulletin MU-137 on Oil Well Pumping Motors and Bulletin MU-185 on the complete line of Wagner Motors. Thirty-two branch offices are ready to assist you in any motor application problem.

**Wagner Electric Corporation**
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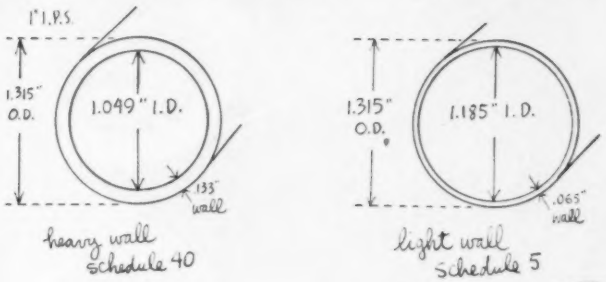
**WAGNER ELECTRIC CORPORATION**
**6389 Plymouth Ave., St. Louis 14, Mo., U.S.A.**

ELECTRIC MOTORS • TRANSFORMERS • INDUSTRIAL BRAKES
AUTOMOTIVE BRAKE SYSTEMS — AIR AND HYDRAULIC

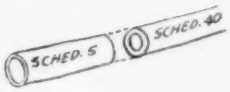
**BRANCHES IN 32 PRINCIPAL CITIES**

M53-8

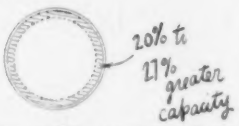
# here's what you gain with stainless schedule 5 pipe



You save money. Schedule 5 pipe costs about half as much per foot as Schedule 40.




Schedule 5 has the same O.D. as Schedules 10, 40 and 80 —for hook-up with existing lines as well as for new installations.




Its larger I.D. increases flow and capacity in pipelines, exchangers and other equipment.

It's lighter. This means quicker and easier installation.

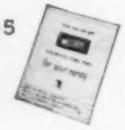
You can save substantially on valves, fittings, weld rods, etc., because smaller O.D. material can frequently be used. Tubing sizes can now be replaced with light wall pipe . . . for ready hook-up with standard valves, pumps, and other equipment normally manufactured in pipe sizes.

Fittings as well as stocks of Schedule 5 pipe are carried by conveniently located Carpenter distributors.

***Specify Schedule 5 pipe . . . it saves dollars . . . and makes a lot of sense!***

**THE CARPENTER STEEL COMPANY**
**Alloy Tube Division, Union, N. J.**
Export Dept: The Carpenter Steel Co., Port Washington, N.Y. "CARSTEELCO"

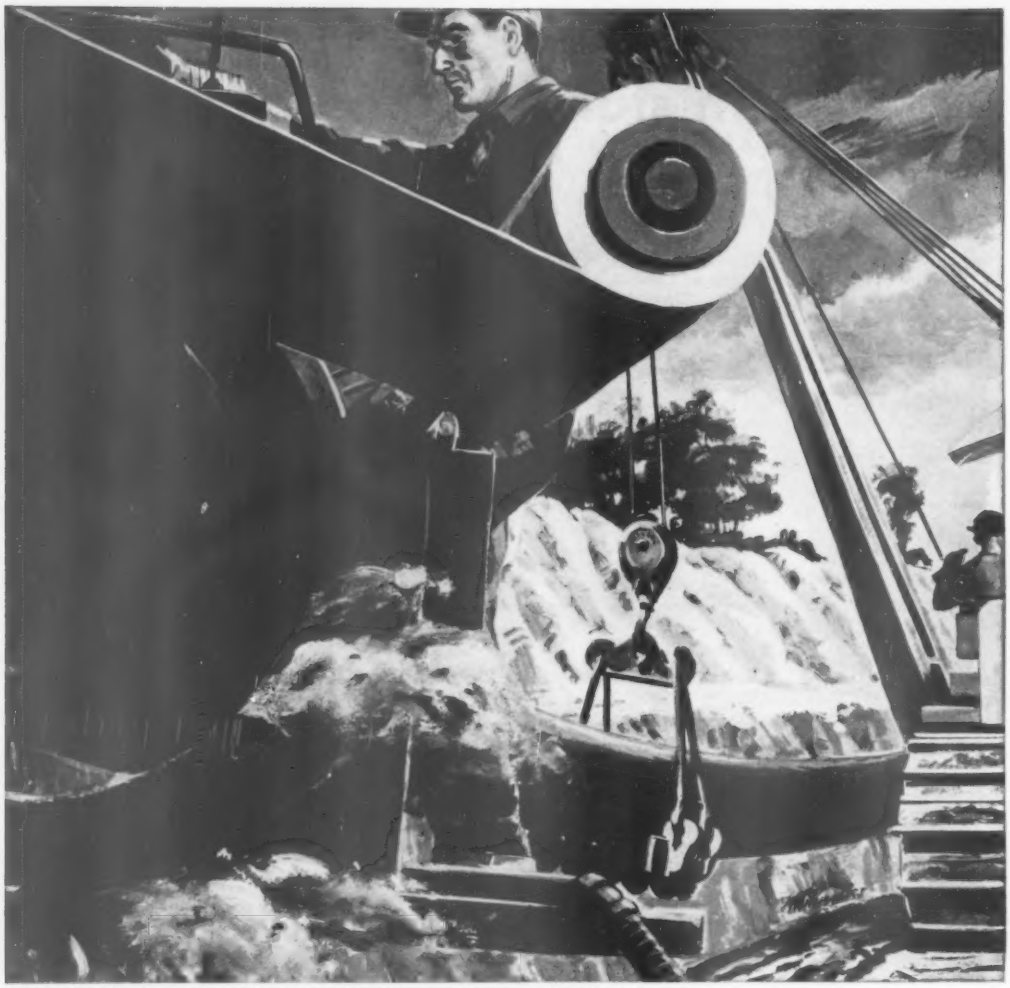
*Data Sheets* give you complete information about Carpenter Schedule 5 Stainless Pipe. Write for your personal copy.



# Carpenter

**STAINLESS TUBING & PIPE**

**- guaranteed on every shipment**



TEMPERA PAINTING BY JAMES MINNICKS ESPECIALLY FOR BARRETT DIVISION

## *Wrapping up the job*

This scene, with the circling arms of the wrapping machine busily binding pipe with a tarred felt wrapper, is familiar to pipeliners. And members of Barrett's Technical Service Corps are an important part of the picture.

These trained men are paid by Barrett to work with *you!* They start when your pipeline job is in the planning stage, helping to determine the best protective coating to meet your specific needs and requirements. Therefore, you are assured in advance that costly pipe will *get* superior protection — to *give* longer service.

And Barrett field inspectors are at your pipeline site whenever needed. The proper application of coal-tar enamels is vital—and a Barrett inspector's advice and supervisory experience can save you time and money. It is for this service that Barrett maintains field offices throughout the country.

For the best in pipe protection, at lowest cost ... Specify Barrett — from *start* to *finish!*

*Reg. U. S. Pat. Off.

**BARRETT DIVISION**
ALLIED CHEMICAL & DYE CORPORATION
40 Rector Street, New York 6, N. Y.
In Canada: The Barrett Company, Ltd.
5551 St. Hubert St., Montreal

# They Say—

### Science Is a Cost Cutter

"The primary reason behind the ability of the petroleum industry to spend more without raising prices correspondingly is its extensive utilization of engineering and scientific manpower.

"It employs over 17,000 college trained engineers and scientists and spends over $130 million per year on research. The inventions which result therefrom enable the industry to offer new and improved products and at the same time, keep costs down.

"Furthermore, the value of inventions stemming from petroleum research has extended far beyond the industry itself in the application of techniques and instruments to other industries."

*Dr. Gustav Egloff, Universal Oil Products Co., addressing the Western Society of Engineers, Chicago.*

### Not a Constitutional Matter

"Attorney General Brownell's suggestion that Congress grant the coastal states authority required for the states to administer and develop submerged-lands resources, rather than a blanket quitclaim title, doubtless is well meant.

"It is very difficult to see offhand anything in the constitution which would prevent Congress, any more than an individual or corporation, from quitclaiming paramount rights or fee simple title or both to anything in which the Government's own rights were a sudden and surprising 'establishment,' and the rights of others to which were more or less conceded long, long ago. If some sort of nominal consideration were deemed advisable in such a transfer, that would be another matter—though hardly a constitutional one."

*Editorial in the New Orleans Times-Picayune.*

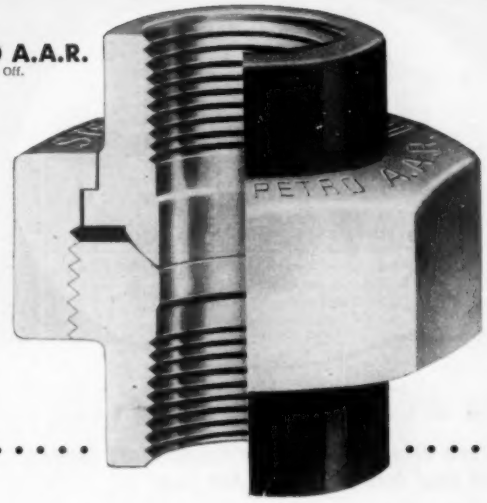
### Chaos in Iran

"All who wish Iran well must be disheartened by the news from Teheran this past week end. Behind the spectacle of rioting mobs filling the streets, there is clearly apparent the clash of rival cliques, each putting its own interests above those of the state, or the Iranian people, and of the larger world community of independent nations to which Iran belongs.

"The discouragement resulting from these events is unrelieved by such comic-opera touches as the swift


## this will ENLIGHTEN you

**PETRO A.A.R.**
Reg. U.S. Pat. Off.




"PETRO A.A.R." Hot Forged of A.I.S.I. 1023 Open Hearth "Killed" Steel—For temperatures from 100° below zero F. to 1000° above zero F. A differential of 40 points (brinell) in hardness is maintained between the male and female seats to prevent seizure of seats at high temperatures.

Nut threads are permanently lubricated with Udylite Cadmium (plated). "PETRO A.A.R." screwed and "PETRO A.A.R." Socketweld are recommended for severe service on ammonia, air, gas, oil, steam, and water, and for general industrial and oil refinery maintenance.

**CLAYTON MARK & COMPANY FORGED STEEL "ORIFICE" UNIONS, SCREWED, OR SOCKET WELD**

For flow control of steam, oil, ammonia, chemicals, water, gas, and air. Also for metering and measuring.
Recommended for working pressures of 600 lbs. at 900° F., or 3000 lbs. at 150° F.
Furnished with Type 304 stainless steel orifice plate and steel-jacketed asbestos filled gaskets.
The orifice plate and gaskets are set in a groove of solid steel to facilitate ease of tightening and safeguard against blowing of gaskets and resultant trouble.
Nut threads of the union are Cadmium plated (Udylited) for permanent thread lubrication.

Sizes ¼" Thru 3"

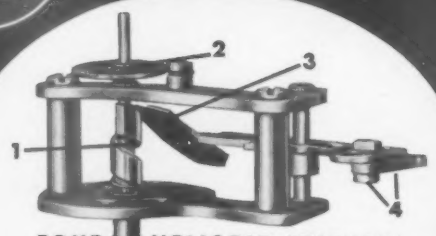
For additional information about these and other Forged Steel Unions write Department O. for Illustrated Catalog or refer to listings in Composite Catalog pages 3194-3195, Refinery Catalog page 695 and Chemical Engineering Catalog pages 1294-1295.

ORDER BY TRADE NAME FROM YOUR LOCAL JOBBER

ORIGINATORS AND PIONEERS OF STEEL UNIONS SINCE 1912
**CLAYTON MARK & COMPANY**
1900 DEMPSTER STREET • EVANSTON, ILLINOIS

ACCO products

HELICOID GAGES




FOUR HELICOID FEATURES

1. Stainless Steel Helicoid Roller (no gear teeth)
2. Stainless steel hair spring
3. Long Life Cam (no gear teeth)
4. Corrosion-resistant link and screws

Why HELICOID Gages...

retain original accuracy longer, last longer, and cost less per gage, per year

NO GEARS, NO TEETH

● HELICOID is the greatest achievement of the gage makers' craft—the pressure or vacuum gage *without gears... without teeth!* The HELICOID movement is a simple cam and roller device that gives long, trouble-free service. It has been tested and proved in years of hard service in the field.

HELICOID Gages are particularly desirable where pressures fluctuate and cause excessive movement and wear of gears in ordinary gages. The smooth operation of the durable HELICOID cam and stainless steel roller keeps the pointer as steady as it was originally even after hundreds of thousands of cycles.

Many sizes, many styles

You can get HELICOID Gages for pressure, vacuum, or compound service—in all pressure ranges; white, black, or radiant faces; wall, stem, flush, and panel mountings, or flangless cases.

ACCO See your distributor or write today for **Catalog G-2**

HELICOID GAGE DIVISION
AMERICAN CHAIN & CABLE
929 Connecticut Avenue • Bridgeport 2, Connecticut

HELICOID Pressure • Vacuum GAGES

changes in the Shah's plans or the sight of Premier Mossadegh fleeing for safety in his night clothes. Whatever the outcome of these turbulent events in Teheran, it is clear that there is neither governmental stability nor political or economic equilibrium in this most important land at the crossroads of the world.

"Political irresponsibility and economic madness such as have prevailed so often since 1950 can easily create a situation in which Moscow, through its Tudeh tools, will take over.

"The free world can only hope that realization of this gravest of dangers will yet penetrate the consciousness of both Mossadegh and Kashani and persuade them to stop short on the path that leads to national suicide. But if the events of last week end are a clue, then understanding is still lacking and Iran's freedom is in mortal danger."

*Editorial in the New York Times.*

**Worried About Surpluses?**

"The oil industry has the jitters.

"What these jitters will mean to the men who work for wages in the industry is not yet clear, but the possibilities of layoffs loom large in both crude production and refining.

"The industry is jittery about markets. There are many indications that the rapid expansion of the industry during the past few years has caused it to outgrow the demand. This undoubtedly is a temporary condition which will be corrected in time—but meantime, some of the companies apparently have more oil—particularly refined products—than they know what to do with."

*International Oil Worker, published by the Oil Workers Interntional Union.*

# CALENDAR

**MAR.**

25-27 Society of Automotive Engineers, national production meeting, Hotel Statler, Cleveland.

28 North Texas Oil and Gas Association, annual meeting, Kemp Hotel, Wichita Falls, Tex.

30-31 Texas Independent Producers and Royalty Owners Association, annual meeting, San Antonio.

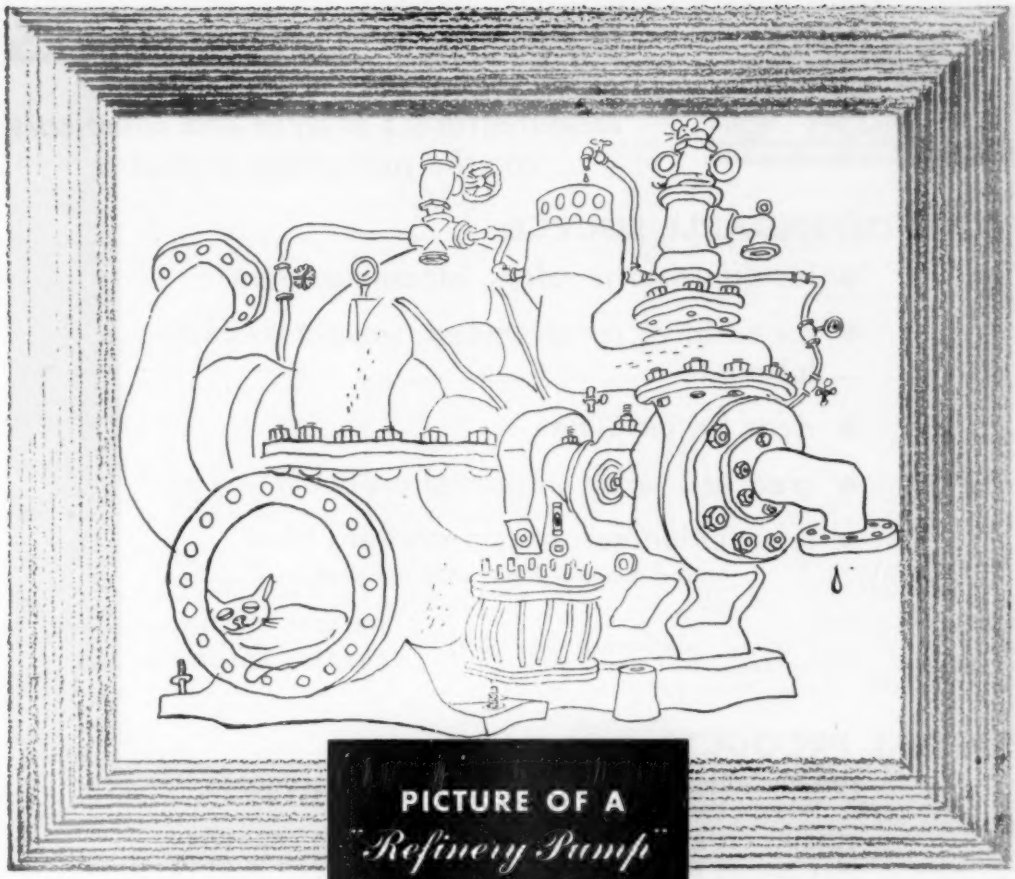
30-Apr. 1 Mid-West Gas Association, Broadmoor Hotel, Colorado Springs, Colo.

**APRIL**

1- 9 American Association of Oilwell Drilling Contractors, eighth annual drilling industry safety clinic, Baker Hotel, Dallas.

7- 8 American Gas Association, research and utilization conference, Hotel Statler, Cleveland.

7- 9 Petroleum Industry Electrical Association, annual convention and exhibit, Shamrock Hotel, Houston.



# PICTURE OF A "Refinery Pump"

"Refinery" pump? There ain't no such animal. But if one pump could be all things to all processes, it *might* look like this. Fact is, however, that in refining *it's pretty important to have each pump fitted to its specialized job.* No *one* answer is good for all.

That's why Byron Jackson builds job-engineered pumps. With a BJ you're sure of a pump that sizes up to the need and is pin-point engineered to profitable performance. Starting with more than 25 basic BJ pump designs used in the refinery field, BJ engineers can incorporate features to meet particular pressure, temperature, corrosive, material or power requirements.

When you need a pump for your refinery operation — check with BJ first!

**Byron Jackson Co.**

*Since 1872*

**P. O. Box 2017 Terminal Annex, Los Angeles 54, Calif.**

OFFICES IN PRINCIPAL CITIES

SEE **BJ** FOR THE ENGINEERED ANSWER TO YOUR PUMPING PROBLEMS

# PATENT CHEMICALS
INCORPORATED

***manufacturers of dyes and chemicals for the petroleum industry***

## YOUR DEPENDABLE SOURCE . . .

- for fluorescent colors, blooming agents
- for additive compounded, solvent extracted lube oils
- dyes for gasolines
- greases, waxes, industrial products
- for aviation gasoline, petrol ero blue

***This material meets Mil-F-5572 Specification***

**"PETROL" COLORS**
for gasoline, kerosene, diesel and tractor fuels . . . Bronzes, Ambers, Blues, Greens, Golds, Yellows, Purples, Oranges, Reds, Browns, Blacks.

**GREASOL COLORS,** for greases

**STEARO COLORS,** for waxes

## SPECIAL PRODUCTS . . .

**FUEL OIL ADDITIVE ELIMINATES FILTER-SCREEN CLOGGING**
Mulsor for improved soluble oils for agriculture sprays

**TURBINE OIL ADDITIVES**

**PETROL BLUE WHITENER R AND B**
are used to neutralize undesirable yellow shades in uncolored gasoline or kerosene.

**DEBLOOMING AGENT A**
has the property of neutralizing blooms in lubricating oils.

**N. P. A. COLOR**
has the property of changing body color of pale oils to red cast, without affecting natural fluorescence.

**GASOLINE ADDITIVES**
. . . inhibitors for gasoline, oil, rust . . . high pressure lubricants, stabilizers, emulsifiers, detergents, wetting agents, dispersing agents.

**BODY COLOR #1**
yellow brown cast for converting pale oils to reds.

**BODY COLOR #302**
red brown cast for converting pale oils to reds.

*In addition to an extensive line of dyes, fluorescent colors, additives, blooming agents, etc., the technical staff of The Patent Chemical Company specializes in petroleum problems and is available for the study and preparation of particular products to meet special requirements involving dyes; fluorescent colors; additives; blooming, wetting, dispersion agents, etc.*

***for complete details write or phone***

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Cincinnati 2, Ohio

PATENT CHEMICALS INCORPORATED
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335 McLean Boulevard
Paterson 4, New Jersey

**pioneers in gasoline colors • petroleum additives**

8- 9 American Association of Oilwell Drilling Contractors, eighth annual drilling industry safety clinic, Baker Hotel, Dallas.

8-10 American Petroleum Institute, division of production, Eastern district meeting, William Penn Hotel, Pittsburgh.

13-15 American Society of Lubricating Engineers, eigth annual meeting, Hotel Statler, Boston.

15-17 National Petroleum Association, midyear meeting, Cleveland.

20-22 American Petroleum Institute, Division of Transportation, products pipe-line conference, Hotel Muehlebach, Kansas City.

21 Association of Consulting Chemists and Chemical Engineers, Inc., Hotel Belmont Plaza, New York City, symposium and dinner.

21-23 Southwestern Gas Measurement Short Course University of Oklahoma, Norman.

22-24 American Association of Petroleum Geologists, Rocky Mountain section meeting, Casper, Wyo.

22-24 American Institute of Electrical Engineers, southern district meeting, Hotel Seelbach, Louisville, Ky.

24-25 Interstate Oil Compact Commission, spring meeting, Roosevelt Hotel, New Orleans.

26-29 American Institute of Chemical Engineers, Chemical Institute of Canada, joint meeting, Royal York Hotel, Toronto, Ont.

27-28 Independent Petroleum Association of America, mid-year meeting, Jefferson Hotel, St. Louis.

APRIL 27-
MAY 1 American Petroleum Institute, safety and fire protection committees sixth mid-year meeting, Galveston, Tex.

Apr. 29-
May 1 Natural Gasoline Association of America, annual convention, Rice Hotel, Houston.

Apr. 30-
May 1 American Gas Association, transmission and storage conference, Edgewater Beach Hotel, Chicago.

MAY

4- 5 American Petroleum Institute, division of marketing, midyear meeting, Baker Hotel, Dallas.

4- 6 Liquefied Petroleum Gas Association, annual convention, Conrad Hilton Hotel, Chicago.

5- 6 Gas hydrate control conference, University of Oklahoma, Norman.

6- 8 American Society of Training Directors, ninth annual conference, Sheraton Plaza Hotel, Boston.

7- 8 American Petroleum Institute, Rocky Mountain district, Division of Production, spring meeting, Gladstone Hotel, Casper.

11-13 Southern Gas Association, Jung Hotel, New Orleans.

11-14 American Petroleum Institute, Division of Refining, midyear meeting, New York.

13-14 Pacific Coast Gas Association, annual gas supply and transmission conference, Santa Barbara, Calif.

14-23 International Petroleum Exposition, Tulsa.

15-16 International Gas Union, council meeting, Paris, France.

19-22 The Institute of Gas Engineers, ninetieth annual meeting, London, England.

21-23 Panhandle Geological Society, field trip, Yucca Hotel, Raton, N. M.

24-27 American Gas Association, production and chemical conference, Hotel New Yorker, New York City.

25-29 American Society of Mechanical Engineers, annual conference and exhibit, oil and gas power division, Hotel Schroeder, Milwaukee.

27-29 Texas College of Arts and Industries, Kingsville, eighth annual short course in gas technology.

28-29 Western Petroleum Refiners Association, regional technical-industrial relations meeting, Broadview Hotel, Wichita.

28-29 Natural Gas and Petroleum Association of Canada, London, Ont.

29-30 West Texas Geological Society spring field trip, Paisano Hotel, Marfa, Tex.

JUNE

2- 3 American Petroleum Institute, Division of Production, Pacific Coast District, Statler Hotel, Los Angeles.

4- 5 Kentucky Oil and Gas Association, annual meeting, Lafayette Hotel, Lexington, Ky.

7-12 Society of Automotive Engineers, summer meeting, The Ambassador and Ritz-Carlton Hotels, Atlantic City, N. J.

14-18 Canadian Gas Association, Windsor Hotel, Montreal, Canada.

15-19 American Petroleum Institute, Division of Production, midyear committee conference, Hotel William Penn, Pittsburgh.

16-19 American Welding Society, national spring technical meeting, Shamrock Hotel, Houston.

18-19 Western Petroleum Refiners Association, regional technical-industrial relations meeting, Conrad Hilton Hotel, Chicago.

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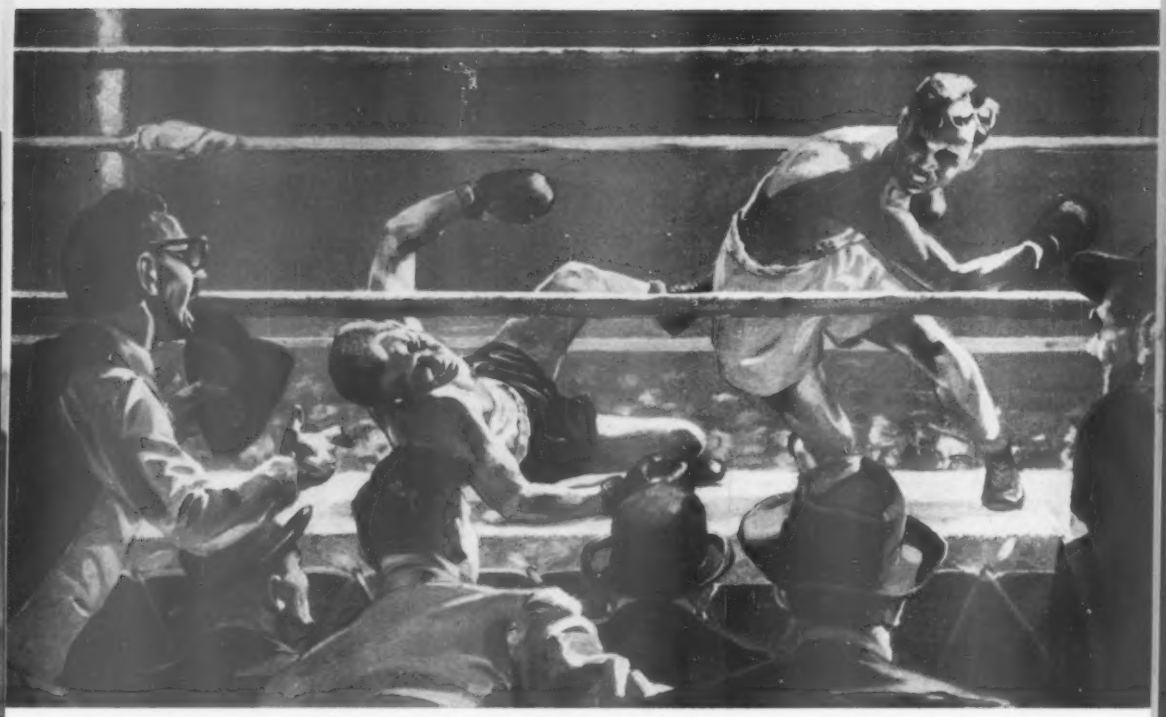

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THE OIL AND GAS
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TULSA, OKLAHOMA

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# JOURNALLY Speaking

## How to Build a Refinery

WANT to build a refinery? This issue of the Big Yellow Book tells you two ways you can do it.

If you are a devotee of the do-it-yourself trend which is featured so much by the popular home-maker magazines and the vendors of paint rollers, power saws, and ready-cut sailboat kits, you can follow the directions in the article on page 304.

But if this looks as though it might get a bit complicated, you can follow the advice in the article on page 278 and just turn the whole thing over to an engineering contractor.

But whether you do your own refinery tinkering or let a contractor worry about the details, you will find a lot of good ideas in this special refining number. We carry plenty of good refining information all through the year, of course, but every spring we make an extra-special effort to corral some extra-good refining material. This is it.

## Atomic Refining

WE are glad to note from an article on page 295 that the refining industry is making a start toward entering the brave new world of the interplanetary future as depicted in the comic books and TV programs, at least to the extent of using atomic energy in its processes. In this case some radioactive isotopes are mixed with the catalyst beads and the speed of their passage through the process is measured by Geiger counters. Any 12-year old boy who saves the right kind of cereal-box tops should be able to explain this.

Not so, however, with the little piece on multicomponent distillation which starts on page 182 and runs on and on through "nonideal solutions" and "various straightforward, short-cut, and algebraic methods." This, unfortunately, is still in the complicated and nonideal world of the present where even the so-called straightforward and short-cut methods are, as the author admits, overwhelmed with a voluminous amount of seemingly unrelated material.

## Replete Reports

ALONG about this time every year, when the plants begin to blossom forth, the oil companies also blossom forth with their annual reports. And, like the plants, the beauty of their blossomings varies greatly.

Some companies reveal no more than the law requires, and their annual reports are nothing but a couple of pages of figures. Others go all out to flossy up their reports with colored photographs, cartoons, and breezily worded text that explains what the auditors' figures mean and adds a lot more information about what the company is doing and why. Our preference is for the fancy kind because it pictures the company as a living, active, human organism, full of real people trying to get ahead in the world—which, of course, the oil industry is.

This urge to tell more and more about the company and its operations has become so strong that at least one company which legally doesn't have to publish any annual report at all has now got into the act with one of the most interesting and most human reports of the lot. This is Carter Oil Co. which, being a wholly owned subsidiary of Standard Oil Co. (N. J.), has approximately one stockholder and could get by with a single copy of its auditor's statement.

Apparently this gave Carter a left-out feeling, so it is now issuing annual reports to its employes. The report gives about as much financial information as most companies' reports to stockholders, and much more general information than many companies reveal. And it is deliberately written for the employes, with such phrases as "The people at the Billings refinery achieved a new high in crude runs . . . Our marketing department people sold more petroleum products, too . . . "

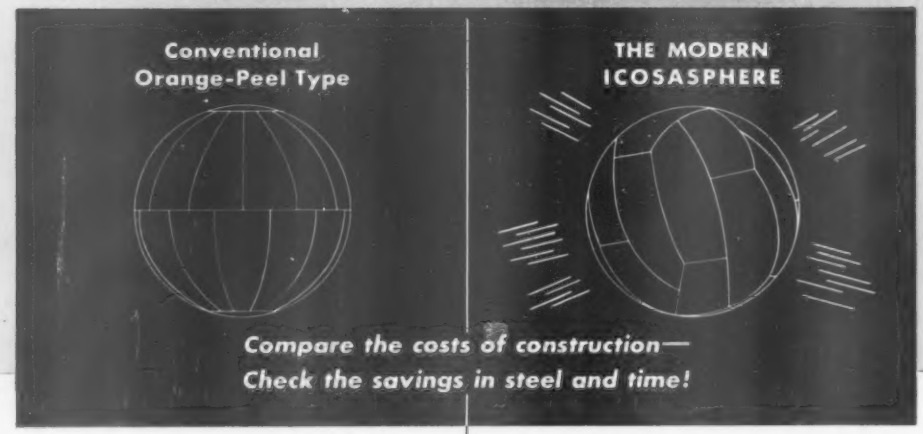
Good stuff, we say. The more people are told about the oil industry the better they will understand what makes it tick.

*—Henry D. Ralph.*

*New* **SPHERE DESIGN** • *New* **LOW COST** •

# THE Icosasphere

U.S. PAT. 2,496,626




Conventional "orange-peel" plate layout for sphere measuring 28.75 ft inside diameter, of 1⅝" plate, for 205 lb working pressure.

| | |
|---|---|
| Total area of plates required | 3670 sq ft |
| Scrap loss | 40% |
| Total length of welded seam | 590 ft |

Icosasphere plate layout for sphere measuring 28.75 ft inside diameter, of 1⅝" plate, for 205 lb working pressure.

| | |
|---|---|
| Total area of plates required | 2970 sq ft |
| Scrap loss | 13% |
| Total length of welded seam | 468 ft |

**Sphere for sphere, the ICOSASPHERE SAVES**

—*46,300 lbs of steel plate*—or, 19% of the steel required by conventional design

—*122 ft less welded joints*—or, 20.7% less welding than conventional design

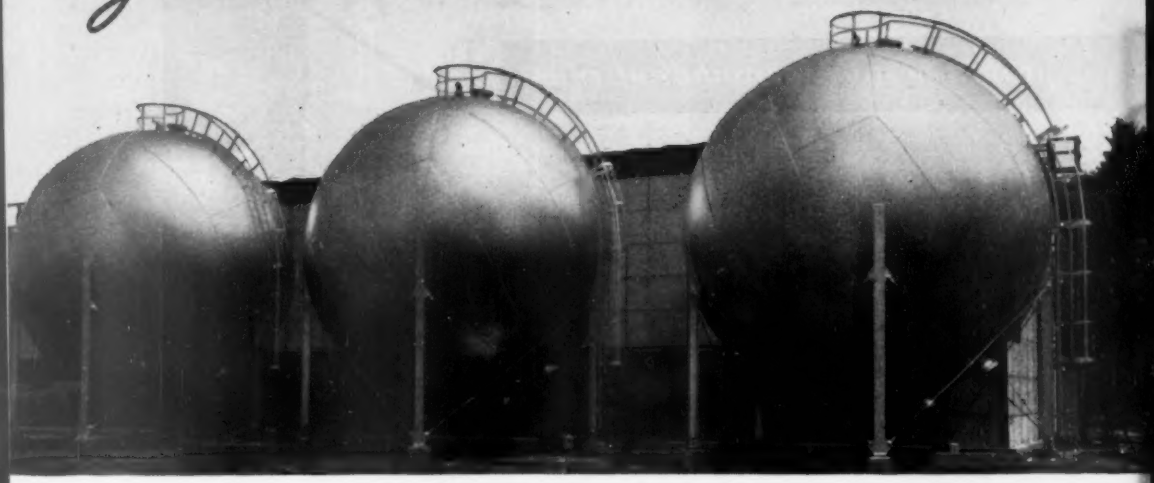
**A new approach to sphere fabrication**

**"The Icosasphere"**

**FOR STORAGE OF LIQUIDS AND GASES**

**AND FOR VACUUM**

# —by PITTSBURGH · DES MOINES



THE ICOSASPHERE*, an important recent development of Pittsburgh-Des Moines, is now at the service of industry for applications where internal or external pressures are a factor. • The unique design of the Icosasphere enables accurate determination of rectangular plate sizes that will cut to desired special shapes with minimum waste. In addition, fewer plates are required, with shorter length of welded seam. • The results: marked economies in material and fabrication; *lower comparative cost* to the purchaser. • If you will write us of your storage problem, we will be glad to provide an Icosasphere quotation. Just address the office nearest you.

* The Icosasphere is a sphere made up of plates whose joints lie on the expanded edges of a circumscribed icosahedron.

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*proved best by thousands of runs*

Truth of the saying "Nothing succeeds like success" is outstandingly proved by the BAKER RETAINER BRIDGE PLUG! The "well proved" design—based upon the long famous Baker Cement Retainer—has performed successfully in countless thousands of wells—for every purpose—at all temperatures—and at all depths.

**IDEAL FOR EVERY PURPOSE**

For new well completions, work-overs, testing, squeeze jobs, well abandonments, and many other installations, you can be sure of fast, efficient, economical results with the Baker Model "K" Retainer Bridge Plug—Product No. 400.

The design of the plug affords ample clearance for fast, safe running-in, and the slips set quickly and positively. The packing element is held in sealing position by lead seals; packs off against all differential pressures; and prevents movement of fluid or gas either up or down the well. There is no need to place cement above the Baker Retainer Bridge Plug to effect a perfect seal, but, if desired, you can dump cement *on the same run* by using a Baker Model "B" Dump Bailer.

**YOUR CHOICE OF TWO EASILY DRILLABLE TYPES**

For temporary service, choose the Baker MAGNESIUM ALLOY Type Bridge Plug; for permanent installations, specify the CAST IRON Type which is stronger than the casing, and will outlast the casing if harmful well fluids are a problem. Either type drills up in record time because the drilling bit contacts the *very minimum* cross-sectional area; the *short over-all length* reduces drilling time; and the *segmented cast iron slips* are quickly broken up with cable tools, or a rotary bit.

**CHOOSE YOUR SETTING METHOD**

A BAKER BRIDGE PLUG (Product No. 400) can be set on tubing or drill pipe (in the same manner as the well known Baker Cement Retainer) but in these days of pipe shortages we suggest that you contact your choice of the leading wire line service organizations for setting a Baker Bridge Plug (Product No. 400-D) on an electrical conductor cable. You can thus avoid wear and tear on your tubing, and worthwhile savings of time result from wire line setting, particularly in deeper wells.

**ARE YOU USING THE BAKER ADVISORY SERVICE?**

Why not call the Baker representative in your area and discuss with him installation of a Baker Bridge Plug? You will find that he has valuable knowledge and helpful suggestions to solve your problems.

**BAKER OIL TOOLS, INC.**

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# BAKER

## RETAINER BRIDGE PLUG

# Refining capacity: adequate for peace but not for war

THE future expansion of refining capacity in the United States is the subject of a mild argument between the Government and the oil industry. Government officials feel that for defense safety there should be an excess of around 1,000,000 bbl. per day; the industry feels it can't afford to build and carry that much standby capacity.

When the Korean war broke out the Government asked for an expansion of 1,000,000 bbl. per day above 1950 capacity. That goal has been reached—through expenditure of about one billion dollars of industry funds. But demand has moved on apace so that we do not now have 1,000,000 bbl. reserve capacity.

THERE are several ways of figuring refining capacity. By the end of 1953 the capacity of operating plants in the United States should be close to 8,100,000 bbl. per stream day. Deducting for normal shutdowns and the fact that some construction will not be completed until late in the year, the capacity works out to about 7,600,000 bbl. per average calendar day this year.

Accepted estimates of 1953 demand call for runs to stills averaging about 6,860,000 bbl. daily. This leaves a reserve capacity of around 740,000 bbl. daily, which is only three-quarters of what the Government wants but is well above the 10 per cent margin which the industry considers sufficient.

Construction projects already announced indicate that during 1954 this country will have a practical refining capacity, on the same basis, of at least 7,800,000 bbl. daily. If demand increases 5 per cent over this year, runs to stills will be about 7,200,000 bbl. daily. Our reserve capacity then will be about 600,000 bbl. daily, or a little under the 10 per cent margin and even farther from the Government's goal.

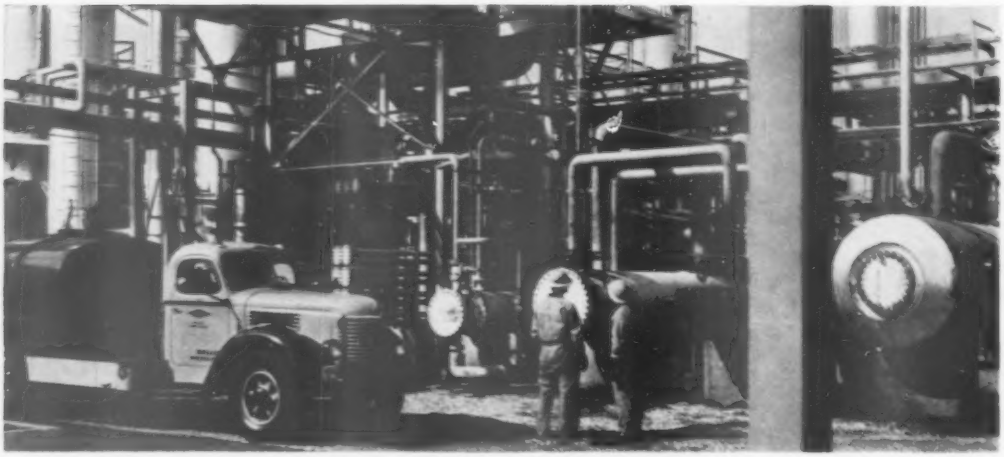
THE industry will, of course, build all the capacity it thinks it will need, and, normally, will carry a reserve margin somewhere in the neighborhood of 10 per cent. But this takes a huge investment. And taxes are so high and the prices of petroleum products are so low that the industry has been hard put to keep its capacity up with the growth in demand.

Nobody wants the Government to build or finance standby refineries for defense. The industry will do it on two conditions: First, it must have the money, which it can get if the public will stand for a small increase in products prices. Second, it must have some assurance that the reserve capacity will not be used to turn out such a surplus of products as to undermine the price structure.

Government assistance will be needed for this second condition. But if the Government planners really want a big excess refining capacity they should take the lead in developing ways to enable industry to finance it.

# CATALYTIC CRACKER OUTPUT INCREASED 6000 BBLS. PER DAY

## Slurry exchangers cleaned chemically by Dowell Service in only 12 hours with profitable results



Through-put on a fluid catalytic cracker in a large refinery was reduced because deposits badly fouled the slurry exchangers. Dowell chemically cleaned the shell side of these exchangers in less than 12 hours. As a result of the cleaning, the operator was able to step up the through-put on the cracking unit from 16,000 to 22,000 barrels per day. This increased efficiency also made it possible to postpone a proposed shut-down for a major overhaul of the unit.

On another catalytic cracker, the increased through-put resulting from Dowell Service had an estimated value of $4,300 per day.

All types of equipment on catalytic crackers have been cleaned effectively by Dowell's chemical methods . . . *without dismantling and with a minimum of downtime.*

Dowell furnishes trained personnel and all necessary equipment. Dowell engineers apply liquid solvents according to the technique demanded by the job: for example, by filling, spraying, jetting, cascading or vaporizing. These solvents are designed to remove deposits quickly, efficiently and economically. Often equipment may be cleaned while it is in operation.

Call Dowell for assistance on your maintenance cleaning problems. Experienced Dowell engineers will be glad to talk with you. No obligation, of course.

*INFORMATIVE PAMPHLET* gives description of how Dowell Service saves time and money in cleaning refinery equipment. Call your local Dowell office or write directly to Tulsa, Dept. C-11.

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*Over 100 Offices to Serve You with Chemical Cleaning for:*

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*Chemical Services for Oil, Gas and Water Wells*

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*A Service Subsidiary of*
THE DOW CHEMICAL COMPANY

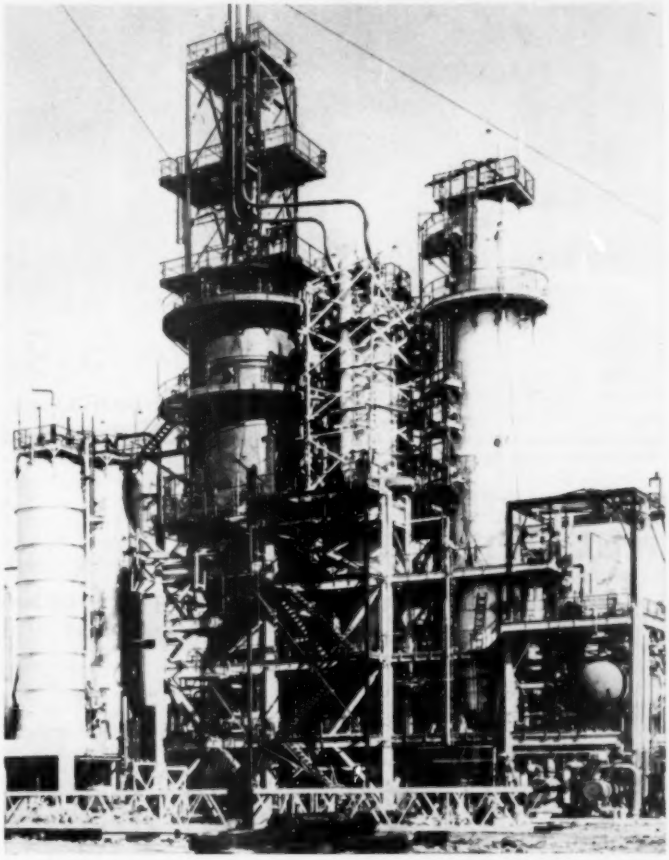
# THIS WEEK

**INTERNATIONAL.**—Arabian American brings Uthmaniyah area into commercial production. . . . Field now producing 100,000 bbl. daily, capacity of the single separator plant. . . . ¶Small Italian tankers follow up court decision against Anglo-Iranian by loading additional cargoes from Abadan. . . . Grateful Iranian Government announces it will sell Italian company all it wants at half price. . . .

**ACTIVITY.**—Production of crude and lease condensate averaged 6,451,650 bbl. daily for week ended March 14, down 14,700 bbl. daily. . . . ¶Total well completions for the week decreased 3 wells to 862. . . . Wildcat completions totaled 191 compared with 196 for preceding week and 137 for same week last year. . . . ¶Rotary rigs operating in United States on March 16 moved up 13 rigs for the week to 2,463. . . .

**TRENDS.**—Demand for heating oils during the winter months was influenced by warmer-than-normal weather in the high-consumption states. . . . From the first of September through the second week of March, the weather in 14 selected cities in north central and northeastern states was 7 per cent warmer than for the same period a year earlier. . . .

**PROCESSING.**—Standard Oil Development releases for first time operating details of its new Model IV fluid catalytic cracking process. . . . First commercial unit now on stream at Imperial's Edmonton refinery. . . . ¶Activated carbons found effective catalysts in forming straightrun naphthas, A.C.S. meeting told. . . . ¶United States refining capacity will pass 8,000,000 bbl. daily this year as a result of an expected gain of nearly 10 per cent in basic crude capacity over 1952. . . . ¶Continued increase in coking capacity in this country over next several years. . . . New processes, growing markets brighten outlook for refiners. . . .

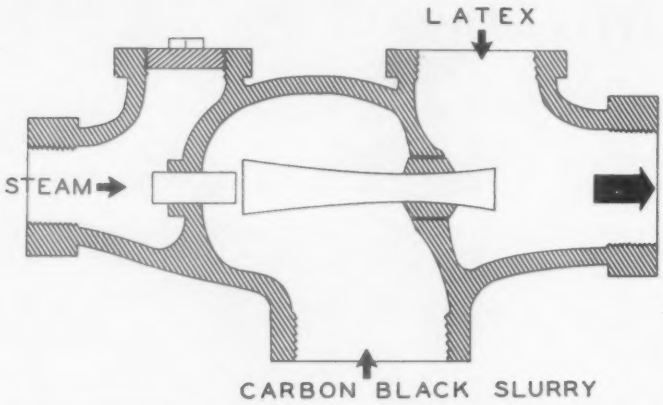


**FIRST OF ITS KIND is this low-cost, simplified fluid catalytic cracking unit recently placed on stream by Imperial Oil, Ltd., at the company's Edmonton, Alta., refinery. Twenty similar units are now under construction in the United States and abroad. How the fluid-cat process was modified to produce a simpler, cheaper, and more easily operated unit has just been announced by Standard Oil Development Co. For operating details, see page 167.**

**CONSERVATION.**—Oil operators producing in the Spraberry trend of West Texas cite variety of complex problems which would result if Texas Railroad Commission should shut in the fields for excessive gas flaring. . . . ¶Standard of California reveals unit operation of Kettleman Hills North Dome field will go into effect April 1, with Standard as operator. . . . ¶Scurry County Canyon Reef Operators Committee appoints H. H. Allen as manager for the newly activated SACROC unit. . . .

**PRODUCTION.**—New producing-depth record set by Shell Oil Co. in Weeks Island field in southern Louisiana. . . . Production is from open hole below 17,000 ft. . . . Well tested 320 bbl. of high-gravity oil daily. . . . Previous record holder in the Wasco field well of California Standard, producing at 15,530 ft. . . . ¶Use of dilute hydrochloric acid and an organic sulfonic acid to increase production is described by Halliburton engineers. . . . Mixture removes aqueous and bentonitic blocking materials from well face or formation. . . . ¶New source of oil and gas reserves is in thin reservoir beds, which now can be located because of recent electric-log developments, A.P.I. told. . . . ¶Texas cuts allowable 119,336 bbl. daily for April. . . .

**INDUSTRY.**—Union Oil Co. and Nassau associates acquire all stock in Thornbury Drilling Co. not already held by Union for reported $4,250,000. . . . Thornbury's principal property is the largely undeveloped Guadalupe field 11 miles west of Santa Maria. . . . ¶Stanwood Oil Corp. obtains control of New Brunswick Oilfields, Ltd., through exchange of stock. . . .




**CROSS-SECTIONAL VIEW of fitting installed in flow lines by Copolymer Corp. to disperse carbon-black through liquid rubber.**

# Rubber Innovation

## Copolymer Corp. reveals new method of dispersing carbon black in cold rubber now under test at Baton Rouge plant

**F. Lawrence Resen**

BATON ROUGE.—A cast-iron fitting, small enough to be carried easily in the hand, is hailed as one of the greatest advancements in the synthetic-rubber industry since 1947 by Col. C. M. Hulings, operating vice president of Copolymer Corp.

The fitting employs a steam jet to disperse carbon black throughout rubber in its liquid state. The product is a cheaper synthetic rubber, Hulings said, which when made into tires results in at least 20 per cent longer tread life than is obtained from the best synthetic tires now in production.

**How it works . . .** The fitting is used within the flow lines of a conventional GR-S operation. High-pressure steam enters an inlet chamber at one end of the fitting and passes through a restrictive opening which directs it into a venturi-type tube, built so as to connect the other two chambers which make up the fitting. Carbon-black slurry enters the second of these through an opening at right angles to the steam flow. Latex enters the third chamber through a similar right-angle aperture, diametrically opposed to and offset from the carbon-black line.

Carbon black is picked up by the steam, passes through the venturi tube, and enters the latex chamber at such velocity as to disperse itself throughout the latex. Water is driven off through conventional drying equipment.

Colonel Hulings said that the tougher rubber produced by this process is less costly due to a reduction in both initial and processing costs. In addition to the improvement in quality, rubber made by the steam-jet process eliminates the use of detergent-like wetting agents necessary in present black masterbatch production, thus cutting production costs.

**STEAM JET used to disperse carbon black throughout synthetic rubber in its liquid form is held by Col. C. M. Hulings, operating vice president of Copolymer Corp., Baton Rouge.**

The dispersion problem, Copolymer explained, has long plagued the rubber industry. Introduction of black masterbatch stock, where the carbon black is added to the synthetic in the latex state rather than in the tire plant, was a definite shortcut in the production cycle. However, uniform dispersion of the black proved to be troublesome and is described as similar to trying to mix talcum powder with water to get a suitable blend.

The steam jet, according to Copolymer Corp., is the answer for the synthetic industry. Another important factor is that the resultant rubber requires smaller amounts of expensive organic chemicals for vulcanization.

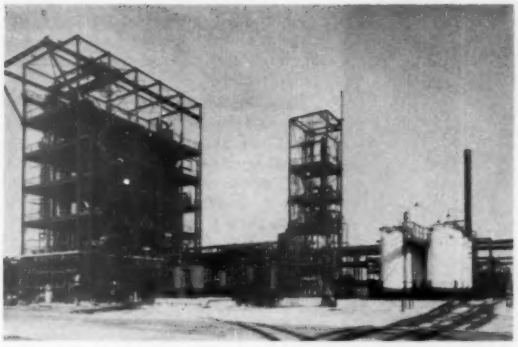
**Road tests . . .** Tires produced from the steam-jet cold GR-S rubber have been given grueling road tests by the government's test fleet in Texas. Preliminary findings, after 18,000 miles of round-the-clock driving, show a 20 per cent improvement in tread wear over control tires of the best "cold" GR-S rubber produced by other methods.

The new process is now in pilot-plant production at Baton Rouge and, under a Reconstruction Finance Corp. program, will be made available to the entire rubber industry.

Copolymer, which introduced cold rubber to the rest of the industry by going into full-scale production in 1947, is a jointly owned operating company supervised by the Office of Synthetic Rubber of the RFC.

Eight participating companies pool their research and technical knowledge in operating the company. They are: Armstrong Rubber Manufacturing Co., Des Moines, Iowa; Armstrong Rubber Co., West Haven, Conn.; Dayton Rubber Co., Dayton; Gates Rubber Co., Denver; Lee Rubber & Tire Corp., Conshohocken, Pa.; Mansfield Tire & Rubber Co., Mansfield, Ohio; Sears, Roebuck & Co., Chicago; and Seiberling Rubber Co., Akron.

An interesting sidelight on the cold-rubber contribution of Copolymer Corp. is that today 75 per cent of the nation's total output of butadiene-styrene synthetics is produced by this "cold" polymerization method.



SYNTHESIS AND PURIFICATION unit at Rohm & Haas plant.

CONTROL ROOM of recently completed installation.

# New Acrylate Process

## Rohm & Haas producing monomers at Houston by continuous reaction of acetylene with carbon monoxide and alcohol

HOUSTON.—An $8,000,000 installation for the manufacture of acrylate monomers by a new process has been completed here by Rohm & Haas Co. at its petrochemical plant.

Acrylate monomers go into a number of important end products—of which plexiglas is possibly the best known.

The new process employs acetylene as a starting material, reacting it with carbon monoxide and an alcohol in a continuous catalytic process, to produce methyl and ethyl acrylates. It is reported more economical than that employing ethylene oxide and hydrogen cyanide as the basic raw materials.

**Economics . . .** The new process permits a drop of 6 to 7 cents per pound from the present price of 48 to 49 cents per pound for acrylate monomers, according to Dr. D. S. Frederick, Rohm & Haas vice president.

The monomers originally were manufactured by Rohm & Haas at their Bristol, Pa., plant by the sodium cyanide — ethylene chlorohydrin reaction. First sales in 1936 were at $1.05 per pound. Later, with natural gas, ammonia, and air as starting materials for the ethylene oxide-hydrogen cyanide reaction, the price was dropped to the 48-49 cents per pound figure.

**Acetylene chemistry . . .** Research toward the new process began with reactions worked out by Dr. Walter Reppe, who as head of research laboratories of I. G. Farbenindustrie in Germany, played an important part in formulating "an acetylene chemistry."

Dr. Reppe showed that acrylic acid esters could be made from acetylene, carbon monoxide, and an alcohol by (1) stoichiometric reaction at relatively mild conditions, and (2) catalytic reaction at high temperature and pressure.

**The new process . . .** Research conducted under direction of Dr. H. T. Neher resulted in development of the new process, which avoids the disadvantages of the Reppe catalytic process. In the Rohm & Haas method the catalytic reaction is superimposed on the stoichiometric reaction involving nickel carbonyl and hydrochloric acid.

High yields of acrylate—between 80 and 90 per cent, based on acetylene and total carbon monoxide—are obtained.

**Other products . . .** The same reaction system is also suitable for manufacture of acrylic esters of higher alcohols, including n-butyl, tert-butyl, 2-ethylhexyl, n-octyl, allyl, and 2-ethoxyethyl. Glacial acrylic acid, acrylic anhydride and n-substituted acrylamide can also be made.

Present manufacture of acetylene at the Rohm & Haas plant is from calcium carbide. However, acetylene can be prepared at the plant from natural gas should future increased volume warrant it.

# Depth Record Broken

## Shell well in southern Louisiana's marshy Weeks Island field flows commercially from open hole below 17,000 ft.

NEW IBERIA.—Louisiana this week laid claim, without question, to having the world's deepest oil production when a well, located in Weeks Island field, in Iberia Parish, was completed as a producer with total depth at 17,183 ft.

This depth exceeds by 1,576 ft. that of the previous deepest producer, Standard Oil Co. of California 5 Mushrush, in the Wasco field of Kern County, California, which produces from the Eocene at 15,530 ft.

The new deepest well, Shell Oil Co. 1 Weeks-Gall unit, on state potential test flowed 320 bbl. of 39.2°-gravity, pipe-line oil with 8,281,000 cu. ft. of gas in 24 hours through 17/64-in. choke with tubing pressure gaging 5,275 psi. Gas-oil ratio was 25,854 cu. ft. per barrel.

Production is from open hole below 16,932 ft., where the last string of pipe, 7-in. liner, was cemented. The oil-saturated zone was logged from 17,038 ft. The 7-in. liner extends from 12,826 ft., being sealed off in 7⅝-in. casing previously cemented at 13,000 ft. The 2-in. tubing in the well is set with production packer at 16,908 ft.

**Salt-dome production . . .** Weeks Island, located 15 miles south of New Iberia in the tidal coastal marshes, is a shallow, piercement-type salt dome, one of the so-called "Five Islands." Long-known as a salt dome and mined for salt many years, first oil production was found in deep sands circling the flanks of the dome in 1945. Steady development since then by Shell, Humble Oil & Refining Co., and Gulf Refining Co.

has proved it one of South Louisiana's most prolific and deepest oil fields.

Drilling at Weeks Island has been edging steadily toward this new deepest producer, and prior to completion of the latter well oil production had been established in sands ranging in depths to below 15,000 ft.

Once before, late in 1951, the field came near breaking the California world's deepest producing record when a well, Shell Oil Co. 1 Gonsoulin, tested high gas-oil ratio production in a sand zone at 16,572-16,600 ft. However, because of the high ratio, the company elected to plug back and complete the well in a slightly shallower sand with oil producing interval at 15,296-336 ft., which was only 226 ft. short of the California record.

Although the latter well did not break the California record, it became the deepest producer in Louisiana, and remained that until last year when its producing depth was exceeded by a well completed by The Texas Co. at Bay St. Elaine, in Terrebonne Parish, at 15,362 ft.

**WEEKS ISLAND drilling is a barge operation. This is Shell's big rig drilling in the area. The company operates one smaller barge-mounted rig in the field.**

## SOUTHWEST

# Rush to Legislate

### Texas solons, working hard to beat deadline for proposing new legislation, flood calendar with oil and gas measures

AUSTIN.—Nearly 200 bills, a large share of them dealing with oil and gas, were submitted by hardworking Texas legislators just before the deadline for this year's session and introduced to the legislature last week.

Most of the bills concerning oil and gas were aimed at increasing taxes, reportedly due to a warning by State Comptroller Robert S. Calvert that the state will be short of funds unless more taxes are levied or funds now tied up by the court dispute over the natural-gas-gathering tax becomes available.

**Omnibus bill . . .** An omnibus tax bill proposed by Rep. George S. Berry, Lubbock, and others would increase the levy on oil production from the current 4.6 per cent to 5.6 per cent of market value to provide about $15,000,000 additional revenue; first the natural-gas-production tax from the existing 5.72 per cent to 7.72 per cent of value at the well head (another $7,000,000); and enact a new tax of 0.25 cent per gallon on gasoline at the refinery ($37,000,000). The bill also would collect 1 per cent of the gross receipts of chemical plants and add another $1,000,000 in taxes on other natural resources to bring the total annual take to about $80,000,000.

An omnibus bill proposed by Rep. Bert Hall, Rio Vista, and others would bring in almost $135,000,000 annually by levying a 1-cent per gallon tax on gasoline processing and a 1 per cent tax on gross receipts of chemical plants, and by increasing the tax on sulfur production 25 cents per ton. He would reduce the take by cutting the retail gasoline tax to 2 cents per gallon—half of the present tax—and cutting other taxes.

A measure taxing oil and gas lines was introduced by Rep. Maury Maverick, Jr., San Antonio. The bill would tax lines larger than 20-in. at the rate of $150 per mile annually; 15 to 20-in. at $85 per mile; 12 to 15-in. at $45; and 12-in. or smaller at $25.

**Tidelands leasing . . .** In a bill intended to prepare Texas to take over and administer the tidelands off its coast, Rep. John A. Warden, McKinney, advocated fixed-bonus bidding for leases on a high-royalty basis. The bill provides for a royalty of at least one-eighth. The land commissioner would be empowered to fix a higher minimum royalty if he believed a higher rate to be justified on the basis of production and other factors.

Sen. Harley Sadler introduced two bills into the Senate—one authorizing the Texas Railroad Commission to approve agreements for the construction and operation of cooperatively owned natural-gasoline facilities, the other would permit any incorporated political subdivision of the state to execute oil and gas leases on its lands and to commit any royalty interest it holds to agreements providing for operation of areas as a unit for exploration, development, and production.

# Shutdown Opposed

### Spraberry operators insist area be kept on production

AUSTIN.—Oil operators producing in the Spraberry trend of West Texas last week urged the Texas Railroad Commission not to shut down the fields because of glas flaring.

In a "show-cause" hearing, the operators cited problem after problem that would be created by a shutdown order and told the commission that by the first of next year facilities will be more than ample to handle all gas produced in the huge trend.

Only one operator dissented. Jack Blalock, Houston attorney representing E. E. Fogelson, asked the commission to take any steps necessary to halt flaring, saying the gas being flared will prove to be worth considerably more than the oil.

One witness estimated that 280,000,000 cu. ft. of casinghead gas daily is now being produced in trend, of which 190,000,000 is being processed in gasoline plants. Of the residue gas from these plants, it was estimated that about 60,000,000 cu. ft. is being utilized and the remaining 130,000,000 cu. ft. is being vented. Gas being flared in the field was estimated at 90,000,000 cu. ft. daily.

Operators told the commission a shutdown order would disrupt the current program aimed at eventual handling of all casinghead gas, would halt efforts now under way to find more efficient methods of oil recovery in the trend, would cause a breakdown in the marketing, supply, and processing programs of many producers, purchasers, and processors.

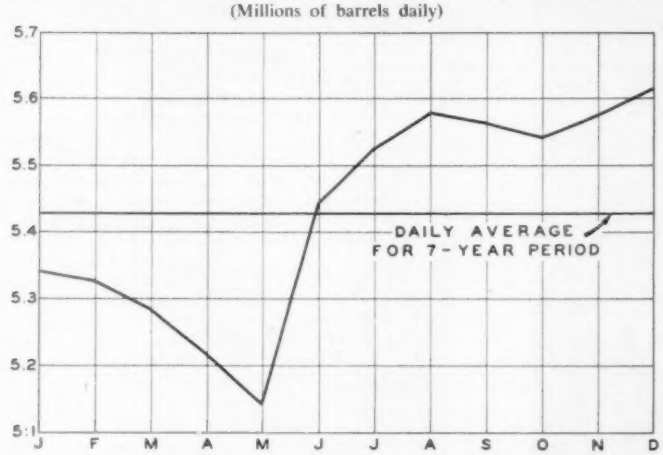
The commission also was told a shutdown might cause a loss in recoverable oil which would exceed the value of the gas being flared and that such an order would nullify a current important proj-

ect to determine the efficiency of Atlantic Refining Co.'s new water-imbibition recovery method.

The area involved is about 55 miles long and 25 miles wide and includes roughly half a million acres.

**Demand for Domestic Crude—Monthly Averages, 1946-1952**

(Millions of barrels daily)




# Allowable Down Again

## Texas Railroad Commission cuts permissible crude output 119,336 bbl. daily from March 14 figure; days set at 19

AUSTIN.—The Texas Railroad Commission cut crude-production allowables for April to 2,921,875 bbl. daily, a reduction of 119,336 bbl. daily from the commission's estimate for March 14.

The cut will be effected by setting the state-wide pattern at 19 producing days for the 30-day month compared with 21 days in January, a 31-day month. East Texas field will be permitted 18 producing days, the same as March.

The current series of reductions started in December, following an upward trend that lasted from July through November. The number of producing days in February indicated a slight increase over January, but the commission's weekly estimate for February 28 was almost identical with the estimate for January 31.

The number of producing days set for March was only one day less than for January, but the estimated calendar-day allowable was much less because of revisions for certain fields where the wells were not making allowables.

The accompanying tables show the commission's estimates for late November, late December, and by weeks since the first of the year as well as the district breakdown of the April allowable.

**Why cut was needed . . .** The need for reduced production in April is shown by an analysis of demand for total domestic crude by months since the end of the war.

If refinery operations in the first half of the year follow the trend that has existed since the end of the war, demand for domestic crude in April will be less than in any of the months in the first quarter.

Average demand for domestic crude by months for the 1946-52 period is plotted on the accompanying chart. For the 7-year period consumption of domestic crude decreased each month through May. The abnormally low figure for May was due to the influence of reduced refinery operations during the refinery strike in 1952. For the other years since the end of the war, the average for April was the low point.

**RAILROAD COMMISSION ESTIMATES OF ALLOWABLES BY WEEKS**

(Barrels daily)

| | |
|---|---|
| November 29, 1952 | 3,387,245 |
| December 20, 1952 | 3,309,473 |
| January 10, 1953 | 3,228,541 |
| January 17, 1953 | 3,243,442 |
| January 24, 1953 | 3,249,616 |
| January 31, 1953 | 3,262,087 |
| February 7, 1953 | 3,231,551 |
| February 14, 1953 | 3,237,156 |
| February 21, 1953 | 3,250,197 |
| February 28, 1953 | 3,262,670 |
| March 7, 1953 | 3,064,987 |
| March 14, 1953 | 3,041,241 |

**APRIL ALLOWABLES BY DISTRICTS**

| | |
|---|---|
| District 1 | 39,986 |
| District 2 | 151,805 |
| District 3 | 467,010 |
| District 4 | 250,912 |
| District 5 | 49,616 |
| District 6: | |
| Outside East Texas | 125,959 |
| East Texas field | 258,059 |
| District 7-B | 131,173 |
| District 7-C | 185,355 |
| District 8 | 952,406 |
| District 9 | 217,046 |
| District 10 | 92,548 |
| Total | 2,921,875 |

# Unit Chief Named

## H. H. Allen gets nod as manager of SACROC unit

SNYDER, Tex.—H. H. Allen, president of a Dallas firm manufacturing expanded shale aggregate, has been appointed conditionally by the Scurry Area Canyon Reef Operators Committee as unit manager for the newly activated SACROC Unit in Kelly-Snyder and Diamond M oil fields in Scurry County, West Texas.

The appointment, made at the first meeting of the new SACROC advisory committee here March 12, is subject to approval of participating operators.

Allen has served as general superintendent of Byrd-Frost, Inc., as vice president and general manager of Utah Natural Gas Co., and as Utah production manager of Three States Natural Gas Co. He also has been employed as assistant chief engineer for Fish Constructors, Inc., Houston.

J. E. Ross, vice president of Tide Water Associated Oil Co., Tulsa, was elected chairman of the advisory committee at the meeting.

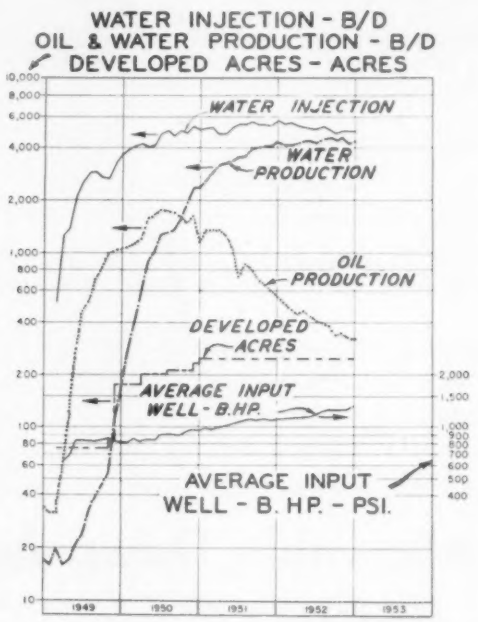
In another action, the committee made permanent the existing committees which had worked toward the unitization project. SACROC Unit was adopted as the official name of the organization.

**Hearings set . . .** The unit became effective March 1 *(The Oil and Gas Journal, March 2, page 39)*. It takes in 47,000 acres with 1,200 producing wells. The huge secondary-recovery operation involves injection of both gas and water.

Proposed field rules will be presented in a hearing before the Texas Railroad Commission March 25, and the following day a plan of water and gas injection will be presented. Proposed injection wells are now being selected.

The unitized area, which included all of Kelly-Snyder field and the north one-third of Diamond M field, has been designated by the Railroad Commission as Kelly-Snyder field.

WATER-FLOOD PUMPER is this electrically driven unit in the Fankhauser project.




WATER-FLOOD RESULTS of Sunray's eastern Kansas project are shown in this chart.

# Successful Flood

## A.P.I. meeting hears of Sunray project in which output climbed 5,200 per cent—from 34 bbl. to 1,797 bbl. daily

TULSA. — Development and operational details of a highly successful water-flood project 135 miles north of here were described in a feature paper presented before the spring meeting of the Mid-Continent district of the American Petroleum Institute's Division of Production, held here March 18-20.

The flood described is the Fankhauser unit of Sunray Oil Corp., in the "Golden Lane" district in eastern Kansas' Greenwood County. Production is from the 1,900-ft. Bartlesville sand (Pennsylvanian age), originally developed in 1926 and 1927.

Before water flooding, oil production from Sunray lease had amounted to 3,960 bbl. per acre. The 23 wells were producing 34 bbl. per day.

At peak production for the water flood, using 22 injection wells interspersed on a 10-acre 5-spot pattern, crude output was 1,797 bbl. per day, a 5,200 per cent increase. This peak was reached 18 months after water was injected into the pilot area.

During the 4-year span of water-flood operations, alone (1949 to 1953), oil producton has totaled 4,950 bbl. per acre, compared to 3,960 by previous natural production.

J. D. Walters, Sunray's petroleum engineer in charge of water flooding and who delivered the A.P.I. paper, said the injected water-oil ratio at the beginning of this year was 15.2 and the produced water-oil ratio was 13.4. The cumulative injected water-oil ratio is 5.07, and on a produced basis is 2.75.

**Core data . . .** Net sand thickness of the flood project is 25 ft., with an average permeability of 80 md. and an interstitial water saturation of 40 per cent.

Walters said salt water is used for flooding, obtained from four 800-ft. supply wells, each of which is equipped with 4½-in. tubing and a 30-hp. electric sucker-rod-type pumping unit.

The Sunray property is completely electrified. The water pressure-plant station employs two horizontal triplex pumps driven by 60-hp. motors. The individual oil-well pumping units use 7.5 and 10-hp. motors.

# Better Completions

## Fracturing, shaped charges, emulsion muds, and removal of flow restrictions cited at A.P.I. production meeting

TULSA.—A unique chemical mixture of dilute hydrochloric acid and an organic sulfonic acid is increasing oil production from both sand and limestone wells.

C. E. Clason and W. F. Hower, of Halliburton Oil Well Cementing Co., Duncan, Okla., told the spring meeting of the Mid-Continent A.P.I. production district that the treatments remove aqueous and bentonitic blocking materials. In treating hundreds of wells

in 18 months, the Halliburton men said, the over-all results have been encouraging.

The chemical mixture is of benefit only when a blocking condition exists in the well face or formation. Many examples of successful treating were cited.

Results in three new Gardner sand wells in Cree-Sykes field of Runnels County, Texas, were described. One well with 14 ft. of pay was treated with 750 gal. and increased from 24 to 64 bbl. of oil per day. Another responded to the same size treatment, from 15 to 80 bbl. per day. The third well, with 48 ft. of pay exposed, went from a trace to 140 bbl. of oil per day.

Considerable success has been obtained with the chemical mix in South Louisiana, the authors said. One well was making 25 bbl. of oil, 6 bbl. of water, and 960 M.c.f. of gas daily through an open choke. Two weeks after treatment, the well was producing 800 bbl. of oil, 7 bbl. of water, and 369 M.c.f. of gas on a 14/82-in. choke.

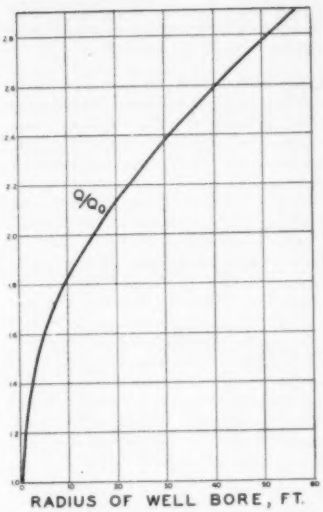
Operations so far in Canada indicate a real use for the mixture, they said. In Alberta's Morinville area a gas test from the basal Cretaceous yielded 5 million cubic feet on a drill-stem test, yet when completed produced only 1 million. After a 500-gal. treatment, the well produced 6 million cubic feet daily.

**Hydraulic fracturing . . .** Five Continental Oil Co. technicians from the company's new production-research laboratories at Ponca City, Okla., presented much know-how on this subject.

The three mechanisms by which production may be helped by hydraulic fracturing, they said, are: Increasing drainage area, breaking through permeability block at the well face, and breaking through a low-permeability formation into a zone of high permeability.

The Conoco researchers stated if there is no permeability block at the well face, then the production increase obtained will be directly related to the amount of additional drainage area produced by the fracture. They said that while no method has been devised for calculating the production increase to be expected from this type of enlargement of drainage area, they have graphed the increase in production to be expected from various well-bore enlargements (see chart).

The Conoco chart shows that increasing the diameter of a well bore from 6 in. to 60 ft. should increase fluid production by a factor of approximately 2.4, or 140 per cent. This




**EFFECT on producing rate (Q/Qo = ratio of "new" to original) of enlarging a 6-in. diameter well bore.**

should be considerably greater than that to be expected by creation of a crack or a fracture extending for a distance of 30 ft. from a well. This degree of increase should be expected regardless of magnitude of the permeability of the formation.

**Shaped-charge perforating . . .** Latest developments are mobile, light-weight shooting units. These combine a recently developed expendable gun with a mobile, light-weight hoist mounted on a two-wheel trailer. The trailer is pulled to the well location by a station wagon or "carry-all."

The shooting line used is a 0.131-in. stranded cable having an electrically conducting core. The drum is driven by a hydraulic system powered by a gasoline engine. The gasoline engine also drives the generator that furnishes the electric power necessary to operate the controls and fire the electrically detonated jet guns. This A.P.I. paper was given by W. M. Russell and G. L. Gore, Dowell Incorporated, Tulsa. The Dowell authors said the "glass gun" consisted of three ⅞-in. aluminum tubes, rigidly fastened together. Glass-encased shaped charges are secured to this framework in any desired shooting pattern.

**Oil in drilling muds . . .** J. L. Lummus, of Stanolind Oil & Gas Co.; H. M. Barrett, Phillips Petroleum Co.; and H. Allen, Carter Oil Co., said that although the cost of using oil emulsion drilling fluids is higher than for ordinary water-base muds, every case studied indicates that the added cost could be offset by the saving of 1 day's drilling time or saving of a fishing job. No instances were found where properly prepared oil-emulsion muds interfered with geological interpretation of cores, cutting, or electrical logs or had other disadvantages, they said.

**Corrosion . . .** Cecil O. Smith, of Carter Oil Co., Tulsa, told the A.P.I. group that damage to steel vessels handling oil-field brines, such as stock tanks and separators, can be greatly reduced, with consequent savings in operating expense. The trick, he said, is to protect cathodically the interior surfaces exposed to brine.

Experiments were conducted by Carter in two types of brine produced in central Kansas to establish a better definition of the protection requirements. A measurable index of the degree of protection was obtained, he said, and the data indicate that an electrical potential of approximately one volt between the steel vessel and a copper-copper sulphate electrode in the brine defines protection for the brines tested.

The estimated protection cost for this ingenious corrosion preventer, derived from experience at 15 anode installations in Kansas, will average less than $3 per tank per month, Smith said.

**Oil-well pumping . . .** Sucker rods always have produced, and still produce more oil than all other methods of artificial lift combined. A recent survey showed 85 per cent of all artificially lifted wells are produced with sucker rods.

There are reasons for believing, however, that the ultimate in the design and operation of sucker-rod pumping systems has not been reached. Further improvement and economy can be effected, according to M. H. Halderson, of Phillips Petroleum Co., Bartlesville, Okla.

In a paper entitled "Artificial Brain Is Required to Solve the Sucker-Rod Pumping Problem," Halderson said a "simulator" could be used to provide a scientific basis for interpreting dynamometer cards. A catalog of typical dynamometer cards for various production rates and depths could be prepared with the simulator. Typical cards would be included to show what happens when wells are pounded, when valves leak, etc. These typical cards in the catalog could then be compared with actual well cards to identify the conditions depicted by the latter.

**Crooked holes . . .** Arthur Lubinski, Stanolind Oil & Gas Co., Tulsa, and H. B. Woods, Hughes Tool Co., Houston, discussing alleviation in inclination

and doglegging in rotary drilling emphasized these important conclusions:

1. Drilling a perfectly vertical hole with an elastic drilling string is impossible, even in horizontal formations, unless very low and uneconomical weights are carried.

2. In crooked-hole territories, cost of drilling may be lowered by: (a) Carrying much more weight and deliberately accepting a larger deviation. This does not result in sharper doglegs; (b) Using larger drill collars with which more weight may be carried without increasing deviation.

3. Extreme reduction in hole clearance, such as by the use of several stabilizers in the lower part of the collar string results in: (a) A decrease in severity of doglegs; (b) A decrease in hole inclination in slightly dipping formations for heavy weights only; (c) No decrease in hole inclination in steeply dipping formations.

4. Sudden large changes of weight in crooked-hole territories cause doglegs and should be avoided.

**Supervision . . .** R. B. Sale, director of training in the production department of Continental Oil Co., Houston, said the goals of supervisory training can be described as (1) training for effective diagnosis of troubles, (2) training for effective action after discovering troubles, (3) training for self-awareness.

*The paper "High Pressure Gas Injection Mechanism of Recovery Increase" by R. L. Slobod and H. A. Koch, Jr., Atlantic Refining Co. research laboratories, Dallas, was also presented at the Tulsa A.P.I. meeting. This paper was presented two weeks earlier at the Fort Worth A.P.I. meeting, and covered in the Journal's March 9 issue, page 70. This important Atlantic paper will be published in full in the Journal issue of April 6.*

# Production Problems

## Cut in imports needed, Pew tells A.P.I. production men; value of thin beds as oil sources discussed by committee

TULSA.—Imports of foreign oil must be restrained and the best method is voluntary action on the part of the importing companies, the Mid-Continent District meeting of the American Petroleum Institute Division of Production was told at its spring meeting here March 18-20.

The speaker was John G. Pew, vice president of Sun Oil Co. and vice president of the A.P.I., who opened the general session.

"Imports must be restrained, and I think it is fair to say that the ones who are in the most advantageous position to do the job are those few who are doing the lion's share of the importing," Pew said. "By the exercise of prudence and restraint, they can, in their own best interests as well as the best interests of the nation, bring an end to this particular problem."

Such voluntary action, Pew said, is preferable to tariffs, embargoes, or other governmental action, but he warned that unless the importers do take some action they might precipitate a crisis which might easily result in legislation designed to close off the American market to their foreign production.

Instead of splitting hairs over when foreign oil supplements or supplants domestic production, Pew said the guide should be the general health of the domestic industry, and he said:

"Allowables have been cut back from the high of last December, imports have increased, and stocks have become excessive. This is prima facie evidence that imports have been supplanting domestic production."

**Trend in business . . .** On another note, A. L. Solliday, vice president of Stanolind Oil & Gas Co., declared that the course of the oil industry in recent years has set a pattern by which all industry can banish the demands for socialism and a return to government controls of business.

Solliday outlined a nine-point platform for business and industry in the modern world, designed to maintain purchasing power and provide for the needs of an expanding population. The oil industry, he said, measures up to these standards very well, particularly in such things as developing natural resources, conducting research to provide more and better things for more people at less cost, and investing capital to provide opportunities for creating new jobs.

**Young retiring . . .** Carl A. Young, director of the A.P.I.'s Division of Production, disclosed during the meeting that he will retire at the end of June after 29 years' service with the A.P.I.

It was generally expected that William H. Strang, assistant director of the division, would be named to succeed Young.

**Thin-bed progress . . .** Thin reservoir beds, recognized by new electric-logging methods, offer a new source of oil and gas reserves, engineers were told at the production-practices committee meeting.

George T. N. Roberts, logging engineer with Shell Oil Co., Tulsa, said the application of new electric-logging methods offered "a more direct approach to the thin-bed problem."

High resolving power inherent in new logging methods such as the Laterolog, MicroLog and Micro-Laterolog, can isolate a hydrocarbon-bearing bed as thin as 3 ft., he said. A thin bed, 5 to 6 ft. thick, could be a commercial reservoir under proper completion and economic conditions, he said in a subsequent discussion.

The MicroLog is a contact resistivity log employing very short electrode spacings with a resolving power equivalent to its total electrode spacing. The Micro-Laterolog utilizes a beamed electric current requiring an electrode spacing of several inches but which exhibits a radius of investigation of about 3 in. The Laterolog employs also a beamed electric current with an electrode spacing usually about 1 ft. Use of beamed electric current results in the formation of a horizontal zone of investigation from the bore hole in which the effects of adjacent beds are minimized; in this manner greater resolution can be obtained in resistivity logging of the bed under study, giving a true resistivity which requires only slight correction from available charts.

**Stratigraphic traps . . .** Exploration implications of thin-bed studies as a field for geological investigation were suggested by Roberts, who observed that recognition of thin pay beds carried a utility beyond serving only as a completion zone. What may be considered to be a thin hydrocarbon interval in an exploratory well may prove to be a discovery reservoir nearby under more favorable sand development downdip, he said, and observed that this problem is related to the geology of stratigraphic traps.

Responsibility of the logging engineer includes the study of old wells to reexamine them for determining the presence of thin beds, Roberts said.

**Bore-hole drift . . .** Techniques to avoid drift in a bore-hole occupied the attention of a subcommittee on bore-hole drift headed by Tom W. Keating, Stanolind Oil & Gas Co., a problem considered more important than correction of deviation after it has occurred. Running of more deviation surveys on producing wells was urged. Commercial applications of directionally drilled holes to obtain production not otherwise available drew committee interest.

## Ringwood Price Hike Refused

OKLAHOMA CITY. — The Oklahoma Corporation Commission last week turned down an application by W. D. Greenshields, royalty owner in Ringwood field, for an increased price for gas in the field.

The proceeding was termed the first case to determine whether a state regulatory body has the authority to set minimum well-head prices for gas produced in an oil field.

Greenshields asked for a minimum price of 10 cents per M.c.f., as compared to the existing approximately 2.75 cents per M.c.f. The price increase was opposed vigorously by Warren Petroleum Corp., operator of the new Ringwood natural-gasoline plant, and Oklahoma Natural Gas Co., joint owner of the plant with Warren and purchaser of the residue gas, both of which produced witnesses testifying that operation of the plant under the 10-cent price would be impossible.

Greenshields contended that the existing price resulted in excessive gas waste in the field. The Corporation Commission ruled that an increase in price would result in greater waste rather than prevent it.

The application of Stanley Coppock for a price of 10 cents per M.c.f. from the Cherokee sand in Ringwood was continued to May 5-7 and May 19-21.

## Fracturing Record Set

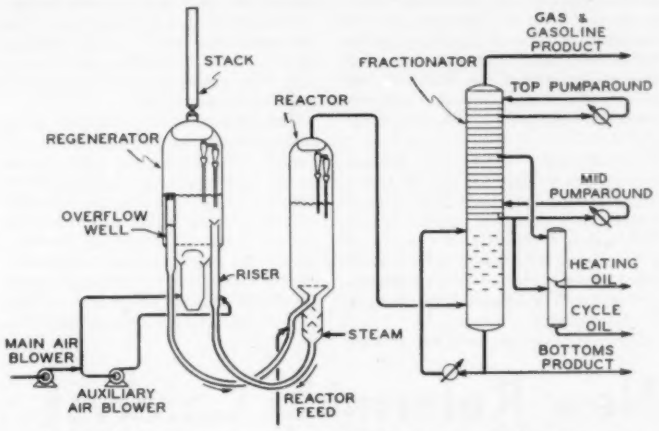
DUNCAN, Okla. — A record well-fracturing treatment, one using 35,000 gal. of fluid, has been performed near here in a Doyle pool well of J. G. Beard and Wichita River Oil Co.

The operation, a Hydrafrac treatment performed by Halliburton Oil Well Cementing Co., used 35,000 lb. of sand with the oil. Normal input is 2,500 to 3,000 gal. of fluid with an average of about a pound of sand to a gallon of oil.

The operation was performed on the 3 Harrell, a well which at first showed only oil stains and produced only 2 to 3 bbl. daily after acidizing. After the fracturing operation the well flowed at a rate of 162 bbl. of oil daily through a 17/64-in. choke with a tubing pressure of 750 psi.

Fracturing operations in Oklahoma normally require amounts of oil and sand slightly above the average but still below those used in West Texas' Spraberry trend, where a common charge is 4,500 gal. The Harrell well, while using a record amount of fluid, was below record in sand input. A previous treatment is on record in which 25,000 gal. of Hydrafrac gel and 62,500 lb. of sand were used.

# INDUSTRY AFFAIRS




**SIMPLIFIED FLOW DIAGRAM of new Model IV fluid catalytic cracking unit.**

# Simplified Fluid Cat

### S.O.D. takes wraps off its new Model IV cracker, says it is cheaper, needs fewer operators, is less complicated

**George Weber**

NEW YORK.—Operating details of a new low-cost version of fluid catalytic cracking, termed Model IV, were announced for the first time last week by Standard Oil Development Co., affiliate of Standard Oil Co. (N. J.).

The first of these units was recently placed on stream by Imperial Oil, Ltd., at its Edmonton, Alta., refinery.

This 11,000-bbl. per day unit is the forerunner of 20 similar units of varying capacity comprising a total throughput of about 295,000 bbl. per day. These new units are now in various stages of construction in domestic and foreign refineries.

**How it differs . . .** The Model IV unit differs from its predecessors mainly in its simplicity and lower cost. It employs an entirely new system of catalyst circulation which permits a lower profile. New units standing less than 100 ft. in height have capacities comparable to earlier units standing 140 ft. or higher. Vessel design, including internals of both reactor and regenerator, have been greatly simplified, say S.O.D. engineers resulting in an estimated 30 per cent saving in steel requirements and materially reduced initial and maintenance costs.

Throttling slide valves, which control the catalyst circulation rate in other units, have been eliminated in the Model IV process. In the transfer system outlined in the accompanying flow diagram, feed stock is charged to the hot regenerated catalyst line at a point just below the reactor. The heat of the catalyst instantly vaporizes the liquid feed and the oil vapor-catalyst mixture moves directly to the reactor.

The density of the spent catalyst from the reactor is lowered as it flows up the riser to the regenerator, by the introduction of air. This permits flow of catalyst from reactor to regenerator under its own pressure head. The catalyst flow rate and catalyst-to-oil ratio in the entire system is thus controlled by the rate of air flow to this spent catalyst transfer line.

In addition to eliminating the need for throttling slide valves, this system also results in more stable operation and easier process control. With controls grouped at a single level near the ground, the Model IV requires less operating personnel. The tangential feed of both oil and air has reduced erosion to an absolute minimum.

From the standpoint of ease of operation and operational stability, S.O.D. engineers state that the new Edmonton unit has exceeded their expectations. "Reverse flow" is much less likely to take place with the new design. A serious pressure differential between reactor and regenerator will cause the fluidized catalyst to "defluidize" in this

system to form an effective temporary "seal" between the two vessels. As soon as the pressures in the vessels return to proper balance, the catalyst "refluidizes" of its own accord, restoring normal circulation. Designers state that this novel principle has made the unit safer, more stable, and easier to operate than any previous fluid units.

**First-unit data . . .** Imperial's Edmonton unit has a design capacity of 11,000 bbl. per day, including 8,510 bbl. of fresh feed averaging 25.7° gravity A.P.I. and 2,490 bbl. of recycle oil averaging 11.8° gravity A.P.I. At 60 per cent conversion, 430° F. end-point gasoline with a clear octane rating of 96 is produced.

This unit is designed for a dense bed temperature of 900° F. and a pressure of 12.8 psig. in the reactor. The catalyst-oil ratio is 10.9 and catalyst circulation is 10.6 tons per minute. In the regenerator, the dense bed temperature is 1,125° F. and the pressure 16.5 psig. The designed coke burning rate is 8,500 lb. per hour.

The Model IV unit is covered by patents owned by Standard Oil Development Co. and the process is available to the industry under license. Foster Wheeler Corp. through its Canadian affiliate, Foster Wheeler, Ltd., of St. Catharines, Ont., completed construction of the Edmonton unit last December. It was part of a $5,000,000 modernization program which also included new vacuum distillation and gas-recovery facilities.

# New Reforming Catalyst

## Activated carbons can be successfully regenerated, A.C.S. told; commercial use indicated in low-pressure operation

**D. H. Stormont**

LOS ANGELES.—Activated carbons, with or without alkaline promoters, have been found to be effective catalysts in the reforming of straight-run naphthas, R. A. Sanford and B. S. Friedman of Sinclair Research laboratories, Inc., told members of the American Chemical Society here March 17.

The Sanford - Friedman paper was presented at A.C.S.' 123rd annual meeting before the Division of Petroleum Chemistry.

Preliminary data from studies conducted at the Harvey, Ill., laboratories of Sinclair indicate successful regeneration, and therefore satisfactory aging characteristics, can be obtained by periodic treatment with steam at 1,300° F., the authors said. It was pointed out, however, that while the process possesses commercial merit as a low-pressure operation, maintenance of catalyst activity by periodic regeneration is not completely assured at present.

The optimum conditions for the process were said to be at amospheric pressure, a process temperature of 1,000° to 1,100° F., and a space velocity of 0.5 to 2.0. Variations in total pressure greatly affect product distribution, with the latter becoming more favorable as the total pressure is decreased. Operating pressures as low as 0.1 atmospheres are worthy of consideration, the authors said.

**Promoters . . .** Considerable variation in effectiveness was obtained with the promoters tested. The alkaline promoters appeared to suppress nonselective cracking and to improve the dehydrogenation activity of the catalyst, but even then considerable cracking occurred. There was a marked difference between potassium carbonate and the other promoters tested.

Data presented showed that carbon catalyst impregnated with $Na_2SiO_3$, $Na_3PO_4$, $K_3PO_4$, and $Na_2CO_3$ gave comparable performances as measured by a reformate octane level (R.M.) of 85 to 86. With $K_2CO_3$, the reformate octane level was only 14. On the basis of coke deposition per octane increase, $K_2CO_3$ was found to be much inferior to $K_3PO_4$, which in turn was quite inferior to the sodium salts.

In tests conducted to determine the comparative value of neutral charcoal with one impregnated with $Na_2CO_3$, it was noted that the octane number (R.M.) of the former was higher, 87.6 to 80.6, but the liquid yield with the untreated charcoal was considerably lower and the dry-gas make was more pronounced. From the relative amounts of hydrogen and methane produced, it was believed the alkali impregnant had decreased the cracking activity and increased the dehydrogenation activity of the charcoal catalyst.

From the viewpoint of regeneration time, it was noted impregnation with alkali was particularly desirable; the catalyst impregnated with $Na_2CO_3$ could be regenerated approximately five times more rapidly at 1,300° to 1,400° F. than the neutral catalyst.

**Diluent comparisons . . .** Comparisons made by the authors between hydrogen and steam as diluents, showed that a somewhat more favorable product distribution was obtained when steam was used. In addition, a steam/hydrocarbon feed mol-ratio of 10 gave better results than a ratio of two.

Discussing catalyst life and effectiveness of regeneration, the authors said maintenance of original catalyst activity was realized in tests where hydrocarbon processing was periodically interrupted to allow catalyst regeneration with high-temperature (1,300° F.) steam. Continuous processing was not possible using steam dilution with an unpromoted carbon catalyst. Catalysts promoted with active water-gas catalysts might permit continuous processing if high steam/hydrocarbon ratios are employed, they said.

**Moving-bed contact coking . . .** Investigations with a bench-scale contact-coking process—which has the advantages of coking in thin films, removing the coke continuously and supplying heat internally — were described by D. C. Jones, T. E. Kelly, and M. B. Neuworth of Pittsburgh Consolidated Coal Co., Library, Pa.

An 18 per cent reduced Kuwait crude with an A.P.I. gravity of 6° was coked in the moving-bed unit at coke preheat temperatures ranging from 975° to 1,155° F. Coke yields ranging from 17.5 to 22.6 per cent (by weight) of the feed stock were obtained, the higher yield being obtained at 1,155° F.

Percentage yields of other products at temperatures of 975° and 1,155° F., respectively, were: Gas ($C_3$ and lighter) 6.6 and 25.0; gasoline ($C_4$ and heavier at 200° C.) 15.2 and 28.0; gas oil (200° to 360° C.) 17.6 and 9.4; and residuum (over 360° C.) 42.0 and 15.0. The coke yields were determined by observing the increase in weight of the contact coke circulated during the run.

From their experiences the authors believed the moving-bed apparatus and technique has utility in catalytic cracking, isomerization, and other studies where vapor phase contact with a granular catalyst of changing activity is involved.

**Bench-scale fluid cat cracker . . .** A bench-scale unit designed to help fill the void between laboratory batch units and continuous commercial plants in fluid catalyst cracking studies was described by J. A. Marshall and J. W. Askins, Shell Oil Co., Houston. They found that many evaluations normally carried out in large-scale pilot plants can be performed at considerable savings in time and expense on the bench-scale unit.

In many cases the unit has proved to be a successful substitute for a large-scale pilot plant in the evaluation of feed stocks, catalysts, and operating variables . . . "thus resulting in consid-

erable savings in capital expense, operating cost, and time, in addition to having lower feed-stock and catalyst requirements."

The continuous, down-flow fluid unit used was contained in an area 2.5 ft. wide, 10 ft. long, and 13.5 ft. high. In regard to operating variables, the weight-hourly space velocity could be varied from 0.5 to 24 and the catalyst-to-oil ratio varied from 2.7 to 22. Reactor pressures could be regulated from 5 to 25 psig. and reactor temperatures as high as 1,000° F. could be reached.

**New deposit-study aid . . .** A research technique which makes it possible to observe the formation and removal of combustion-chamber deposits in automobile engines for a relatively short time during any stage of the deposit growth was described by Dr. Harold P. Landerl and Dr. Bernard M. Sturgis, E. I. du Pont de Nemours & Co., Inc., Wilmington, Del.

The technique involves use of motor fuel containing radioactive tetraethyl lead. Exact location and distribution of the radioactive lead salts which the additive deposits within the combustion chamber can be detected by means of X-ray film, Dr. Landerl said.

During the experiments, the radioactive TEL was added to the gasoline for a relatively brief period. The small amount of radioactive deposit which accumulated during this period essentially photographed itself on X-ray film placed on top of the deposit for 5 hours.

Previous studies, Landerl said, have shown that after many hours of engine operation, relatively large pieces of deposit have flaked off. The radioactive TEL research has shown that much smaller particles break off all the time the engine is running. These particles, he said, melt as they pass through the burning gasoline and stick to another part of the cylinder.

# Trends in Processing

## Crude capacity now being concentrated in larger plants; small refiner closing gap in use of catalytic processing

**George Weber**

UNITED STATES refining capacity will pass the 8-million barrel mark sometime this year. The Oil and Gas Journal's annual refining survey listing operating capacity and new facilities due for completion this year, indicates an annual gain of more than 9 per cent in basic crude capacity over 1952.

Attending this increased capability for charging crude is a substantial construction program for conversion facilities aimed at greater flexibility, higher distillate yields, and improved product quality. The nation's catalytic cracking capacity will reach 2,744,000 bbl. per day this year, up roughly 25 per cent from 1952. Catalytic reforming capacity will more than double, and facilities for gas recovery, polymerization, alkylation, and other associated operations will show important expansion.

**TABLE 1—U. S. CAPACITY FOR CATALYTIC CONVERSION, BY TYPES—1953***

| Type of process— | BPSD |
|---|---|
| Catalytic cracking: | |
| Fluid | 1,908,117 |
| T.C.C. | 553,759 |
| Houdry, fixed bed | 155,278 |
| Houdriflow | 112,900 |
| Cycloversion | 14,150 |
| Total | 2,744,204 |
| Catalytic reforming: | |
| Platforming | 176,070 |
| Hydroforming, fixed bed | 69,333 |
| Houdriforming | 18,000 |
| Hydroforming, fluid | 17,000 |
| Catforming | 15,250 |
| Cycloversion | 10,500 |
| Total | 306,153 |

*Reported as in operation or due for completion during 1953.

Catalytic processing shows strong indications of even greater growth in the future, as related to crude capacity. In catalytic cracking, Table 1, the fluid process has shown widest acceptance, representing nearly 70 per cent of total capacity. Platforming, introduced 4 years ago, has maintained leadership in catalytic reforming capacity. This year will mark the beginning of large-scale adoption of catalytic reforming in general, with the construction of units ranging in size up to 30,000 bbl. per day.

The nature of the industry has changed materially since the war. How much is clearly indicated by comparing the current survey with a similar one conducted in 1946. Table 2 breaks the industry down into refineries of seven classes, based on crude charging capacity, and compares these groups on crude, thermal cracking, and catalytic cracking capacities.

**Bigger refineries . . .** A definite trend toward the concentration of more of the nation's crude capacity in large refineries has accompanied the record postwar-construction program. Those plants showing less than 20,000 bbl. per day capacity have dwindled in number and total capacity. With the exception of many small skimming and cracking plants which have shut down since the war, most refineries have gained successively in size.

As a result, 22 refineries, rated in excess of 100,000 bbl. per day, today account for more than 44 per cent of the country's crude capacity. The number of refineries rated over 50,000 bbl. per day has almost doubled since the war. On the other hand, less than 16 per cent of total capacity is now represented by plants of less than 20,000 bbl. per day, in comparison with 29 per cent in 1946.

**Small plants modernizing . . .** Although the giant refineries of today dominate the crude capacity picture, they by no means enjoy any substantial edge over smaller plants with respect to modern facilities. An important result of the postwar-expansion effort has been the modernizing of refineries in the small and medium-size classes. In both thermal and catalytic cracking capacity, refineries of 20,000 bbl. per day capacity

**TABLE 2—U. S. REFINING CAPACITY, BY REFINERY SIZE GROUPS, 1946 AND 1953**

| | Crude charging capacity, BPSD | | | | | | Thermal cracking cap., BPSD | | | | Cat. cracking cap., BPSD | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1946 | | | 1953 | | | 1946 | | 1953 | | 1946 | | 1953 | |
| Refinery size in crude capacity, BPSD— | No. of refs. | Total | % of total | No. of refs. | Total | % of total | Total | % on crude | Total | % on crude | Total | % on crude | Total | % on crude |
| Less than 1,000 | 57 | 24,705 | 0.5 | 10 | 5,343 | | 300 | | | | | | | |
| 1,000-4,999 | 157 | 382,400 | 7.2 | 97 | 245,106 | 3.0 | 81,570 | 20.2 | 45,401 | 18.1 | | | 3,390 | 1.4 |
| 5,000-9,999 | 81 | 516,700 | 9.7 | 73 | 488,723 | 6.1 | 192,550 | 37.2 | 137,706 | 28.2 | 25,700 | 5.0 | 50,110 | 10.2 |
| 10,000-19,999 | 45 | 595,100 | 11.3 | 41 | 552,500 | 6.8 | 286,350 | 48.0 | 184,725 | 33.4 | 55,400 | 9.3 | 129,420 | 23.4 |
| 20,000-49,999 | 44 | 1,217,050 | 23.0 | 50 | 1,532,078 | 19.0 | 810,100 | 66.5 | 439,044 | 28.6 | 260,700 | 21.4 | 599,378 | 39.1 |
| 50,000-99,999 | 15 | 1,031,900 | 19.5 | 27 | 1,699,133 | 21.0 | 740,550 | 71.6 | 536,149 | 31.5 | 250,300 | 24.2 | 633,106 | 37.2 |
| 100,000 and over | 12 | 1,529,200 | 28.8 | 22 | 3,567,400 | 44.1 | 924,350 | 60.4 | 1,209,500 | 33.8 | 361,750 | 23.6 | 1,328,700 | 37.2 |
| Total | 411 | 5,297,055 | 100.0 | 320 | 8,090,283 | 100.0 | 3,035,770 | 57.2 | 2,552,525 | 31.5 | 953,850 | 18.0 | 2,744,204 | 34.0 |

TABLE 3—EFFECT OF CURRENT REFINERY-CONSTRUCTION PROGRAM ON PROCESSING CAPACITIES, BY COMPANY

(All capacities in 1,000 BPSD)

| Crude capacity controlled by refining companies | No. companies | Crude capacity 1951 Total | Crude capacity 1951 % of total | Crude capacity 1954+ Total | Crude capacity 1954+ % of total | Catalytic cracking capac. 1951 Total | Catalytic cracking capac. 1951 % on crude | Catalytic cracking capac. 1954+ Total | Catalytic cracking capac. 1954+ % on crude | Catalytic reforming capac. 1951 Total | Catalytic reforming capac. 1951 % on crude | Catalytic reforming capac. 1954+ Total | Catalytic reforming capac. 1954+ % on crude |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Less than 10 | 159 | 500 | 7.2 | 570 | 6.9 | 17 | 3.4 | 82 | 14.4 | 10 | 2.0 | 28 | 4.9 |
| 10 to 19.9 | 16 | 207 | 3.0 | 285 | 3.4 | 61 | 29.4 | 108 | 37.9 | | | 12 | 4.2 |
| 20 to 49.9 | 22 | 649 | 9.3 | 842 | 10.2 | 214 | 33.0 | 296 | 34.9 | 6 | 0.9 | 45 | 5.2 |
| 50 to 99.9 | 2 | 143 | 2.0 | 171 | 2.1 | 51 | 35.7 | 76 | 44.5 | 3 | 2.1 | 7 | 4.1 |
| 100 to 299.9 | 10 | 1,556 | 22.3 | 1,853 | 22.5 | 540 | 34.7 | 750 | 40.3 | 5 | 0.3 | 100 | 5.4 |
| 300 and over | 8 | 3,919 | 56.2 | 4,526 | 54.9 | 1,281 | 32.7 | 1,680 | 37.1 | 70 | 1.8 | 239 | 5.3 |
| Total | 217 | 6,974 | 100.0 | 8,247 | 100.0 | 2,164 | 31.0 | 2,992 | 36.3 | 94 | 1.3 | 431 | 5.2 |

and larger, show a similar balance based on crude. Substantial gains in catalytic cracking as related to crude capacity have been made by many plants rated at less than 20,000 bbl. per day.

The current construction program indicates that the small refiner is continuing to close the gap on modern catalytic processing. Table 3 indicates the expansion which has taken place since the institution of the Controlled Materials Plan in 1951. It includes many projects now under construction and some which are not yet begun, and projects planning refinery construction into 1954 or later.

The data in this table are based on refiners' applications for materials allocations and are considered as firm commitments to build. Additional capacity over and above that shown in Table 3 is indicated on the separate basis of applications for accelerated amortization. However, many such projects have not yet been translated into the active planning stages and are considered much less firm an indication of what the near future will bring in new construction.

It should be noted that Table 3 lists the sizes of companies and not refineries. Refiners are broken down according to the crude-charging capacity they controlled in 1951, through their own refineries or those of subsidiaries.

This comparison of the independent and major classes of refiners over a current 4-year period shows that the smaller processor is keeping pace in practically all cases. The balance on catalytic cracking and catalytic reforming is strikingly uniform throughout the scale, with the exception of the operator controlling less than 10,000 bbl. per day. Up to the present, many in this group of small refiners have bettered their larger competitors by their early adoption of catalytic reforming. Although several large cat reformers now are under construction by major oil companies, the independent refiner continues to keep abreast. In addition, smaller companies which have continued in operation since the war appear to be holding their own in the overall program for expanding basic crude capacity. It appears that a healthy competitive situation has resulted from postwar construction. With well-balanced operations which in many cases are superior to those in the large refineries, the independent has greatly strengthened his position in the industry as regards processing facilities.

# Shipments Off

## January exports, imports well below December totals

BOTH imports and exports were down in January, according to data compiled and released by the Census Bureau of the Department of Commerce.

Total imports into continental United States averaged 1,145,000 bbl. daily in January compared with 1,212,000 bbl. daily in December and 978,000 bbl. daily in January 1952.

IMPORTS INTO CONTINENTAL UNITED STATES

(Thousands of barrels)

| | Jan. 1953 | Dec. 1952 | Jan. 1952 |
|---|---|---|---|
| Crude— | | | |
| Mexico | 509 | 709 | 1,022 |
| Colombia | 1,350 | 1,335 | 1,616 |
| Venezuela | 10,404 | 10,108 | 10,354 |
| Kuwait | 2,704 | 3,337 | 1,570 |
| Saudi Arabia | 3,247 | 3,543 | 932 |
| Iraq | 186 | 342 | |
| Canada | 172 | 96 | 101 |
| Far East | 789 | 671 | 448 |
| Total crude | 19,361 | 20,141 | 16,043 |
| Daily average | 624 | 650 | 518 |
| Products— | | | |
| Residual fuel | 15,548 | 16,681 | 12,928 |
| Other products | 601 | 741 | 1,330 |
| Total products | 16,149 | 17,422 | 14,258 |
| Daily average | 521 | 562 | 460 |
| Total all oils | 35,510 | 37,563 | 30,301 |
| Daily average | 1,145 | 1,212 | 978 |

EXPORTS*

| | Jan. 1953 | Dec. 1952 | Jan. 1952 |
|---|---|---|---|
| Crude | 2,211 | 2,991 | 2,303 |
| Gasoline | 2,645 | 4,640 | 2,552 |
| Kerosine | 324 | 509 | 750 |
| Distillate fuel | 2,117 | 2,995 | 1,870 |
| Residual fuel | 1,367 | 1,502 | 1,816 |
| Lube oils | 902 | 920 | 1,293 |
| Other products | 919 | 739 | 746 |
| Total all oils | 10,485 | 14,296 | 11,330 |
| Daily average | 338 | 461 | 365 |

*Excludes shipments to territories.

Crude imports were off 26,000 bbl. daily with most of the decrease in receipts of crude from the Middle East. Compared with January 1952, crude imports were up 106,000 bbl. daily. Most of the increase over last year came through larger imports from the Middle East with some gain in receipts from the Far East.

Product imports were down 41,000 bbl. daily from January but up 61,000 bbl. daily from January last year.

**Sharp drop . . .** Except for the very low average last October, crude and product exports in January were at the lowest level since March 1951. The January average was 123,000 bbl. daily less than in December and 27,000 bbl. daily under January 1952.

Compared with December, the largest decrease was for gasoline, down almost 2,000,000 bbl. for the month. However, decreases were reported for all classifications listed in the table except miscellaneous products. Most of the gain here was in asphalt and coke.

## Chemistry Awards Presented

LOS ANGELES. — Dr. Robert B. Anderson, U. S. Bureau of Mines, Bruceton, Pa., was awarded the $3,000 Ipatieff Prize in chemistry for 1953 and Prof. Robert W. Schiessler, Pennsylvania State College, the $1,000 Precision Scientific Co. Award in petroleum chemistry during the American Chemical Society's annual meeting here last week.

Anderson, the third recipient of the Ipatieff award which is made every 3 years to a scientist under 40 for "outstanding chemical experimental work in the field of catalysis or high pressure," won the prize for his research work on the synthesis of liquid fuels and chemicals from coal. Previous winners of the prize were Dr. Louis Schmerling, Universal Oil Products Co., Chicago, and Dr. Herman E. Ries, Jr., Sinclair Refining Co. research laboratories at Harvey, Ill.

Schiessler currently is directing the American Petroleum Institute's "Project 42" at Penn State, an investigation of pure hydrocarbons in the lubricating-oil range, their synthesis, and the corre-

lation of their chemical structure with their physical properties. He already has succeeded, the society said, in synthesizing and determining the properties of scores of hydrocarbon components in gasolines, lube oils, and other petroleum products. He also was instrumental in discovery of a new synthesis process for a super-explosive during World War II.

## Imports Resolution

### I.P.A.A. asks Congress to legislate 10 per cent lid

SAN ANTONIO.—The Independent Petroleum Association of America urged Congress last week to limit crude and products imports to 10 per cent of United States domestic demand in a resolution drafted at a special imports-policy meeting here.

The resolution proposes that Congress impose quota restrictions on a quarterly basis to limit imports to an amount not exceeding 10 per cent of domestic demand for the same quarter of the previous year.

The I.P.A.A.'s import-policy committee said that hope for a voluntary solution of the imports problem is vanishing. It said a national policy asserting that imports should not retard exploration and development of a maximum supply of domestic oil to meet the needs of the nation was adopted by all segments of the industry, including importers, through the National Petroleum Council, but that this policy had not been accepted in practice.

The resolution alleged that United States production rates are being forced down and that tax revenues and economies of the oil-producing states are being affected adversely, also that drilling activity has slackened. All these things the resolution said, indicate a weakening of the domestic oil industry.

The imports meeting was attended by representatives of 40 independent companies from 13 oil-producing states.

### Colorado Tax Move Revived

DENVER.—The latest attempt to get a severance tax on oil and gas production written into Colorado law has passed its first major hurdle.

The Colorado house of representatives has given its preliminary approval of a bill which would tax production on a graduated scale up to 5 per cent. If the house puts final approval on the bill, it will go to the senate where opposing forces apparently are about equally divided.

The legislation would place a minimum tax rate of 2 per cent on the first $25,000 of annual production from any oil or gas well, 3 per cent between $25,000 and $100,000, 4 per cent between $100,000 and $500,000, and 5 per cent over $500,000.

Colorado voters during the last national election rejected by about 2 to 1 a proposed constitutional amendment which would have permitted the state to levy a 5 per cent severance tax on the gross value of all oil and gas produced within the state's boundaries. The preelection battle over the severance-tax amendment developed into one of the state's hottest political scraps *(The Oil and Gas Journal, November 17, 1952, page 251).*

### Thornbury Stock Sold

LOS ANGELES.—Union Oil Co. and Nassau associates have acquired 100 per cent control of Thornbury Drilling Co., whose principal holding is the largely undeveloped Guadalupe field 11 miles west of Santa Maria.

Union previously held a 51 per cent interest in the firm, with the remaining interest owned by W. M. Thornbury and W. H. Geis, president and vice president, respectively. Consideration involved was reported to be approximately $4,250,000.

At the Guadalupe field 35 producers indicate an ultimate producing area of more than 3,000 acres and a reserve in excess of 65,000,000 bbl. of 9° to 12° gravity crude. It is estimated 375 additional wells will be required to complete the development of the two-pay field, which currently is producing about 2,300 bbl. daily.

In addition to Guadalupe, Thornbury holdings include about 2,100 acres in nearby Casmalia field. A total of about 700 bbl. daily of heavy crude is being produced from the 38 wells completed on this property.

## Industry Briefs

**NEW YORK.—For the third year in** a row, a motion picture produced by the Oil Industry Information Committee of the American Petroleum Institute has been cited by Freedoms Foundation, Inc., for making an outstanding contribution to the principles of freedom. The latest oil film to win the award was "Crossroads, U.S.A."

**WILLISTON, N. D.—North Dako**ta's annual oil-discovery-day celebration will be held here April 18. The event will include a parade, barbecue for an estimated 15,000 people, carnival, and a banquet at which Dr. Robert E. Wilson, chairman of Standard Oil Co. (Ind.), will be principal speaker. The celebration commemorates the discovery of North Dakota's first oil, in Amerada Petroleum Corp.'s 1 Clarence Iverson on April 4, 1951.

**WINNIPEG, Man. — Imperial Oil** will start construction work shortly on a $750,000 catalytic polymerization plant at its Winnipeg refinery. The plant will produce high-octane gasoline to blend with other gasolines.

**SAN FRANCISCO.—Standard Oil** Co. of California announced last week that unit operation of the Kettleman Hills North Dome field will become effective April 1. California Standard will operate the unit for all participating companies under terms of the unit agreement.

## CANADA

### Stanwood Boosts Holdings

NEW YORK.—Stanwood Oil Corp. has obtained control of New Brunswick Oilfields, Ltd., through an exchange of stock.

John M. Kaye, New York banker and Stanwood president, said the transaction greatly increases Stanwood's oil holdings. New Brunswick Oilfields, with headquarters in Moncton, New Brunswick, holds leases on about 3,000 sq. miles, including offshore rights on about 3,000 sq. miles in the eastern third of the province.

The company also owns a 300-bbl. skimming plant at Weldon and has some crude-oil and natural-gas production. Its crude reserves are estimated at a minimum of 1,000,000 bbl.

Stanwood was reorganized in December 1950. It has producing properties in Pennsylvania and royalty and lease interests in the Southwest. Its Pennsylvania reserves are estimated at around 5,000,000 bbl.

### Refinery Expansion Planned

EDMONTON. — American Northland Oil Co. is planning an expansion program in its Wainwright, Alta., refinery it recently purchased from Wainwright Refineries, Ltd.

The contemplated construction program would increase capacity from 800 to 2,000 bbl. per stream day and cost an estimated $329,925. Existing equipment would be used where possible.

The Wainwright company used the plant to process 19°-gravity crude brought by truck from Wainwright field. American Northland plans also to process crude from Lloydminster and Leduc fields. The company owns 25 wells in the three fields.

# Outlook for Coking

## Growing markets, new processes, and other factors point to a continued increase in coking capacity at refineries

George Weber

REFINERS today are showing a mounting interest in the coking of heavy residual stocks. Coking capacity in this country stands at an all-time high, and an expansion of about 25 per cent is now firmly committed or already under way.

Further expansion of coking for the next several years is strongly indicated for several reasons. In order to maintain or improve their over-all picture on product realization, refiners must continue to reduce heavy-fuel-oil yields and increase yields of light and middle-distillate products. Coking is one way to do this.

In addition to the conventional delayed coking processes which offer attractive prospects for the refiner, new continuous processes are due shortly to become commercial. Although the price of coke itself is a relatively minor factor, the market for coke, both as a fuel and a source of carbon, is promising.

**Coking capacity . . .** The current refinery survey conducted by The Oil and Gas Journal (See page 312) includes the most complete plant-by-plant listing of coking facilities ever published. This survey lists primarily, the modern units employing the delayed coking process.

Including a few units on which data were unreported, 33 domestic refineries at the first of this year included modern coking facilities with a charging capacity of 249,000 bbl. per stream day, capable of producing 7,000 short tons of petroleum coke. New facilities in six refineries, totalling about 60,000 bbl. per day for the production of 1,550 additional tons of coke, are projected or under construction.

Over 75 per cent of the nation's petroleum coking capacity is centralized in the Great Lakes and Mid-Continent areas. The Pacific Coast, with 15 per cent, is considered a likely area for additional capacity. Although coking is not now practiced to any extent in other refining areas, there are strong indications that it will receive substantial adoption in the Rocky Mountains, and will spread in the Gulf Coast and East Coast areas.

**Coke production . . .** The production of petroleum coke over the past 20 years has shown a general increase, excepting for the early war years. The decline in the early 1930's resulted from the rapid adoption of improved thermal cracking processes which replaced the outmoded shell cokers.

**MOST IMPORTANT consumer of petroleum coke for nonfuel use is the aluminum industry. Calcined coke goes into the manufacture of electrodes, which convey electrical current through electrolytic cells to reduce alumina to aluminum. This operator is changing an electrode in the pot room of the Reynolds Metals Co. plant at Jones Mill, Ark.**

According to preliminary figures of the U. S. Bureau of Mines, the 1952 production of petroleum coke was 18,123,000 bbl., down 874,000 bbl. from 1951. Applying the bureau's conversion factor of 5 bbl. per short ton, the 1952 production totals over 3.6 million tons. It should be noted that this production exceeds the rated capacity of modern delayed coking units, since some older facilities remain in operation.

While coke production has risen fairly consistently since the war, coking operations have not kept pace with over-all refinery operations during the past 3 years. The "yield" of coke on a national basis rose to a modern high of 0.0087 bbl. of coke per bbl. of crude processed in 1949, and dropped to 0.0076 bbl. last year. On a weight basis, last year's coke "yield" was on the order of 1.02 per cent.

The decline in coke "yield" during the past 3 years is a result of several factors, including substantial annual gains in crude runs, a "wait and see" attitude on the part of some refiners planning new coking facilities, and a temporary lessening in the downward trend in heavy-fuel prices in some parts of the country, resulting from the Korean war. The ratio of coking to basic crude processing is expected to resume an upward trend shortly.

Since the coking operation is influenced by many economic variables, few economists will attempt to project future production. Coking is not directly related to capacity, since many refiners employ coking as a flexible operation, designed to maintain their heavy-fuel production in balance with the market.

**Coking economics . . .** A refiner's interest in coking might be said to vary inversely with the price of heavy fuel oil. The current attention being given this process stems for a gradually deteriorating market for heavy fuel oil in many parts of the country and a continuing economic pressure to recover more of the bottom of the crude barrel for catalytic feed stocks.

As practiced in modern units, delayed coking produces a clean cat feed stock from any type of crude. But it must be weighed in each individual case against three alternate processes for obtaining additional overhead product from the residual fraction. The relative economics of delayed coking, visbreaking, vacuum distillation and propane decarbonizing require detailed study. *(See The Oil and Gas Journal, April 14, 1952, page 156, and this issue, page 300.)*

**Processing progress . . .** Coking technology has made rapid strides in the past several years, and further progress is indicated for the near future. The delayed cokers which now dominate the field are a vast improvement over previous methods. New developments in mechanical and hydraulic coke removal and handling have greatly reduced operating costs and have brought the conventional coking process to a point closely approaching that of a continuous operation, despite its cyclic nature. Several new units of this type are now under construction here and abroad, and more are planned.

The remaining disadvantages involving the removal and handling of coke, and the cycling of streams to coking drums, have caused much research effort to be directed toward development of fully continuous coking processes. The commercial realization of two such techniques is now imminent.

**Continuous contact coking . . .** The first company to announce the development of such an improved process was The Lummus Co. Their Continuous Contact Coking process was developed in a number of laboratory and pilot plant

installations culminating in a 100-bbl. per day semicommercial unit located at the Watson, Calif., refinery of Richfield Oil Corp.

An initial unit of commercial size was built at the Sunray, Tex., refinery of Shamrock Oil & Gas Corp. This 1,000-bbl. per day plant was completed last summer and experimental operations have since been under way to perfect the process.

The Lummus Co. reports that development work is progressing and that continuous runs of successively longer duration are resulting. Between these runs, engineers are making certain mechanical improvements which do not involve fundamental changes in the process, but contribute to smoother unit operation and reduced downtime. Full confidence is expressed that the process will be fully commercial soon.

This process will operate on the moving-bed principle. The preheated charge is contacted with preheated coke particles passing through a contacting zone in the top of the reactor. The wetted coke particles flow uniformly through the reactor as a bed, and coke is deposited in a thin layer on each particle.

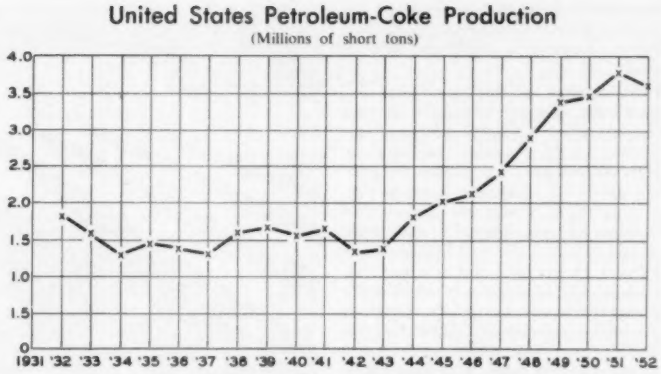
The coke stream passes from the bottom of the reactor into a reheater from which it is recirculated to the top of the reactor. As the coke particles grow to a predetermined size, they are screened out as net coke production. The product is low in volatile matter and high in density and mechanical strength.

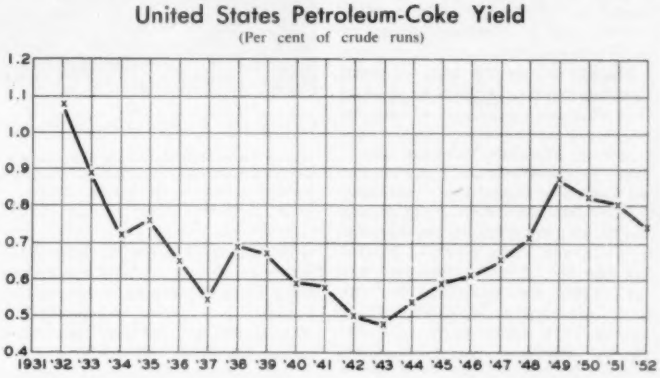
**Fluid cokers coming . . .** Still other continuous coking developments are in the making. The next process to be introduced will employ the fluidized bed, and will be analogous to the fluid catalytic cracking process, excepting that finely divided coke will be circulated through the reactor in place of catalyst.

Standard Oil Development Co., an affiliate of Standard Oil Co. (N. J.), has in operation at Baton Rouge a large-scale fluid coking plant of semi-works size. Development of this fluid type of process has progressed to the point where design work is proceeding on units of commercial size. The construction of one or more of these fluid cokers may be begun before the end of this year.

One of the major engineering and construction firms in this country is also working on the development of fluid coking, but has no progress report to make at this time.

**Coke markets . . .** Although the demand for coke, and the resulting price it commands are not the primary considerations when viewing this process with relation to others, the outlook is for an expanded market.




With a heating value on the order of 16,000 B.t.u. per pound, petroleum coke is considered an excellent fuel. About half of the current production is so consumed. This potential fuel demand represents an apparently unlimited outlet, particularly for the high-sulfur cokes—at a price. Some refiners burn pulverized coke under stills. Others have established outlets for power generation, cement manufacture, tobacco drying, and household consumption.

While the industry may reasonably count on this fuel-demand backlog, there is a growing feeling that the non-fuel, or commercial, uses of petroleum coke should improve its market position in the future. Coke is today finding its way into many such commercial markets.

Its primary outlet both now and in the foreseeable future lies in the manufacture of electrodes and synthetic graphite. Carbon electrodes used in the production of primary aluminum represent the greatest non-fuel outlet for coke. In the form of electrodes, calcined petroleum coke finds other metallurgical end uses in the refining of steel, magnesium, sodium, zinc, and nickel.

Electrochemical uses include the manufacture of chlorine, caustic soda, caustic potash, chlorates, etc. Processed coke goes into the manufacture of certain welding electrodes and dry-cell batteries. Commercial electrical end uses include motor and generator brushes, resistor discs, and radio rectifier tube parts.

Carbon from processed coke finds additional use in the manufacture of silicon carbide (Carborundum) and is fused with sand to produce whetstones and other abrasives.

In the form of molded shapes, calcined coke is used for self-lubricated piston rings, bearings, and valve parts. When mixed with clay, low-ash petroleum coke reduces certain oxides present in the clay to produce bricks of improved color. Some commercial promise is attached to a new laboratory development which converts coke to high-purity carbon dioxide for dry ice, beverage, and fire-extinguisher uses. The method contacts finely divided coke and iron ore in a fluidized bed to produce $CO_2$ undiluted by nitrogen.

The major commercial demands of petroleum coke may be forecast with fair accuracy. Since electrodes used for aluminum manufacture are made almost exclusively from petroleum coke, this particular outlet may be plotted on

the basis of the aluminum industry's expansion plans, provided no competitive source of carbon is introduced into the field.

At the first of this year, plant capacity for primary aluminum in this country stood at 1,225,000 tons annually and Canadian capacity at 500,000 tons per year. Plans for adding to U. S. facilities indicate that total primary aluminum capacity in millions of tons annually will stand at 1.36 by mid-1953, 1.44 by the first of 1954, 1.75 by 1955 and 2.1 by 1958. Canada meanwhile plans to add a major plant which will bring that country's producing capacity to 725,000 tons annually. Two other major projects, now in the planning stage, may be on production by 1958; a 200,000-ton plant in Alaska and a 250,000-ton project in Africa's Gold Coast.

Roughly 0.6 to 0.7 tons of green petroleum coke is required to produce 1 ton of primary aluminum. Using the lower factor and assuming capacity production of aluminum over the next 5 years, it appears that the United States and Canada will consume a maximum of 1,100,000 short tons of petroleum coke for aluminum production this year. By 1955, the same potential market may rise to 1,550,000 tons and one may hazard the prediction that domestic and foreign demand for U. S. coke in 1958 might reach 1,700,000 tons for aluminum production alone. It should be repeated that these figures represent maximum demand estimates.

The current figures are borne out by an authoritative study conducted several months ago, to determine the probable 1953 requirements for U. S. coke to meet four end uses considered important from the standpoint of national defense. The total prospective demand this year, including exports, was placed at about 2,000,000 tons for the following: aluminum 1,300,000 tons; commercial electrodes 350,000 tons; calcium carbide 260,000 tons; abrasives 100,000 tons. These figures are currently believed to be on the high side.

Should the commercial and industrial demands for coke meet the above estimates this year, the percentage of petroleum coke burned as fuel may decline to less than half of total domestic production. Exports are currently high, having increased consistently since the war. Average foreign shipments during the 5 years 1948-1952 were 647,000 short tons annually, about 19 per cent of domestic production. During 5 prewar years, 1937-1941, exports averaged 237,000 tons annually, 15 per cent of total production over the same period.

**Coke quality . . .** By comparison with the fairly standardized specifications of other petroleum products, coke varies widely in quality. Volatile matter may range from 8 per cent to 18 per cent by weight, depending on the type of process, the type of feed stock, and process conditions.

On the average, volatiles comprise about 12-14 per cent. Since the volatile content of green coke is reduced to less than 0.5 per cent by calcination in the manufacture of electrode carbon and synthetic graphite, a relatively high volatile content does not seriously limit a cokes use for such end products.

Another variable in coke quality results from sulfur content. Reflecting the type of reduced crude charged to the coker, petroleum cokes may range in sulfur content from a trace up to 5 per cent. Small volumes are available with sulfur contents below 1 per cent and most coke falls in the 1½-2½ per cent class.

Some research has been directed toward sulfur removal from petroleum coke. The Colorado School of Mines has found that light olefins, when passed through coke at elevated temperatures, will remove over 90 per cent of sulfur compounds present in the green coke, reducing its sulfur content to 0.1 per cent or less. *(See "Removal of Sulfur from Petroleum Coke," Quarterly of the Colorado School of Mines, Vol. 47, No. 3, July 1952.)*

The suggestions of some coke processors that refiners give more attention to coking low-sulfur-reduced crudes is unrealistic since byproduct coke quality is a minor economic factor. However, where segregation of sweet and sour charge stocks is feasible, a higher price could generally be realized from the low-sulfur coke.

The ash content of various crudes is also reflected directly in the quality of residual coke. For electrode, graphite, and other special uses a low ash content is desired, although the type of impurities is often of greater importance than the percentage. Iron, silicon, lime, and magnesium compounds are undesirable for metallurgical coke.

Coke transportation costs are high, hence the geographical location of coking units sometimes plays as important a part as quality in the demand and price it brings. These factors, superimposed on the effect of variable supply characteristics of coke, result in a wide price range. For non-fuel uses, coke commands prices which range upward from $8 per ton on contracts which bind the buyer to take all production from a coker on an "if, as and when" basis. Some quality coke, graded and bagged, brings as much as $60 a ton.

Because of the many factors which influence coke prices, each refiner must investigate his particular markets before he can include coke realization figures in the over-all picture on coking. Although in the past the price of this byproduct may have been relegated to a minor position in determining coking economics, it appears that potential improvements in demand should add to the significance of this factor in future operations.

## Oil Show Flag Gets Its Repairs, Too

**One of the world's biggest flags, that which flies over the International Petroleum Exposition, is shown here being stretched out for mending to put it in shape for hoisting above the exposition grounds on opening day, May 14. Wind-frayed edges were trimmed, cutting the size of the 40 by 60-ft. flag to 37½ by 57 ft. The huge flag weighs about 100 lb.**

# National Affairs

## Quitclaim Urged

### House committee approves bill to give states title

WASHINGTON.—A House judiciary subcommittee last week agreed on a tidelands quitclaim bill, hedged by a provision for return of mineral rights to the states if the courts rule against state ownership.

The full committee will take the measure up this week in the hope of sending it to the House for passage before the Easter recess. Indications were that the committee would make some changes in the measure, which is not satisfactory to Texas and Louisiana interests.

While the subcommittee voted for return to the states of those submerged lands lying within their recognized boundaries it also provided that the Continental Shelf beyond state boundaries should be the exclusive preserve of the federal Government.

The states, accordingly would have no police, tax, or other powers beyond their seaward boundaries and would not participate in the revenues from oil and gas leases and production unless Congress specifically provided.

Under the measure, existing state leases would be recognized by the federal Government but lessees would be required to pay extra royalties equal to whatever is now imposed by the states as "severance" or similar taxes.

A Senate committee is expected to report a similar bill, providing first for quitclaim and second for return of the mineral rights if courts should rule against the quitclaim.

## Endacott Heads Study Group

WASHINGTON.—The National Petroleum Council will make a study for the Petroleum Administration for Defense of the manpower, equipment and material requirements of oil and gas exploration and development.

The study will be made by a committee to be headed by Paul Endacott, president of Phillips Petroleum Co., with 28 members from interested branches of the industry appointed by Council Chairman Walter S. Hallanan.

The information was sought by PAD to support its contention that in event of an all-out war the continuous drilling of a substantial number of wells would be necessary annually throughout the whole war period.

# WATCHING WASHINGTON

**Bertram F. Linz**

## Where Oil Men Are Scarce

The United States Government has developed a great interest in oil in recent years and that interest will continue to grow in the future. But of the many men in some 30 federal agencies interested in the subject, outside of the Interior Department's Oil and Gas Division, those who have had actual experience in the oil industry could probably be counted upon one's fingers—with a finger or two left over.

During the war the Petroleum Administration for War and more recently the Petroleum Administration for Defense contributed much of the actual operating know-how needed to solve the oil problems that arise in any emergency, and the military services, of course, took in oil men to deal with their particular requirements.

In normal, peaceful times, however, the Government's handling of oil questions is much like that of a restaurant without any cooks—everybody has a different idea of what should go into the stew. An oil policy could be stated as simply and concisely as the Monroe Doctrine, but efforts to write one have bogged down because everybody wants to add something different to it.

Practical questions of importance to the industry are involved in national security, under the Defense Department; the expansion of European refining capacity, under the Mutual Security Agency; our relations with other countries, under the State Department; imports, synthetic fuels, and a host of other subjects in which the Government is interested.

Since it is impractical to concentrate all oil activities in one agency, the suggestion has been advanced that after the emergency agencies fold the Oil and Gas Division should be expanded, not only to deal with such problems as still remain, such as aviation gasoline, but to serve as a center of practical information for other agencies dealing with oil matters.

## Vociferous Truckers

Over-the-road tank carriers are up in arms over an Interstate Commerce Commission ruling that "ghost" competition justifies reductions in railroad freight rates on petroleum.

A grant of authority to the railroads to cut rates up to 40 per cent on oil moving from El Paso to Arizona to meet threatened but nonexistent pipe-line competition will have the effect of eliminating all tank-truck carriers over paralleling highway routes, it is contended.

Spokesmen for the trucking industry assert this is a reversal of the long-held rule of the commission that carriers seeking to reduce rates on the ground of other carrier competition must furnish proof that such competition actually exists.

The tank carriers contend that the new rate setup ignores the national transportation policy and the public interest.

The truckers also assert this case is one of several which have been brought to the commission by the railroads in recent years in an effort to eliminate over-the-road competition and say that, strangely enough, the cost basis on which they made their case is the same as that which they have used to secure 12 increases in rates since 1936.

## Import Fears

Domestic producers may have to cut back production another 300,000 or more barrels a day during most of this year because of imports of foreign oil, it is estimated by Russell B. Brown, general counsel of the Independent Petroleum Association of America.

Although domestic production last month averaged 7,200,000 bbl. daily, Brown predicted that the required domestic output of petroleum liquids for the year may drop to an average of 6,875,000 bbl.

Brown challenged estimates by the importing companies that entries this year will average 1,077,000 bbl. daily and said they may be substantially above that figure unless checked.

The I.P.P.A. official also had a few words for the recent report of the public advisory board of the Mutual Security Agency which recommended that all duties and restrictions on oil be eliminated and if the domestic industry suffers as a consequence it be helped by such things as extension of unemployment insurance, assistance in retraining workers, diversification of production and conversions to other lines.

MIDDLE EAST

# Uthmaniyah Producing

## Output of big field, still not defined, running at 100,000 bbl. daily; Aramco preparing for 7-mile stepout to south

THE Uthmaniyah area in Saudi Arabia has been brought into commercial production by Arabian American Oil Co. as a result of the completion of separator facilities and last spring's construction of a 30 and 31-in. pipe line to Abqaiq.

Uthmaniyah is now providing about 100,000 bbl. daily of the company's total production of around 800,000 bbl. daily. This is the capacity of the single Uthmaniyah gas-oil separator plant, which was built late last year in the northern end of the area. Eight wells are tied into the plant, and four more are being connected.

The 30 and 31-in. line extends 53 miles north and east to the stabilization plants at Abqaiq. The line now is running about 200,000 bbl. daily, consisting of the Uthmaniyah crude and another 100,000 bbl. daily through a connection with Ain Dar Separator Plant 4 completed earlier last fall.

Uthmaniyah is the southernmost of three producing areas located in a rough triangle within what has been designated as the Greater Ghawar field. To the northeast is the new Shedgum area through which the 30 and 31-in. line extends. Ain Dar is to the north of Uthmaniyah.

**Limits not defined . . .** The south end of Uthmaniyah is still not defined. Aramco is moving in equipment for a new long stepout, Uthmaniyah 32, which has been located about 11 km., or nearly 7 miles, south of the present southernmost well. There are 26 completed wells in Uthmaniyah where development is being carried out on the characteristic ring-spacing plan.

Relatively short undrilled breaks also separate Uthmaniyah from Shedgum and Ain Dar. There is a gap of about 8 km., 5 miles, between the Shedgum and Uthmaniyah and the Ain Dar and Uthmaniyah wells. Ain Dar, discovered in 1948, as the first of three Ghawar areas, now has 51 producing wells and the drilling program is nearly finished.

**Tremendous potential . . .** Drilling which has been methodically carried out since the original Ain Dar discovery *(The Oil and Gas Journal, November 1, 1951, page 40)* indicates that the entire Ghawar field ranks as one of the world's greatest oil accumulations. Approximately 100 km., or 62 miles, separates the northern end of Ain Dar from the present southernmost wells in Uthmaniyah. Shedgum, with seven completed wells and two rigs running, is still in an early stage of development. Aramco has equipment in the field for construction of another separator plant in about a year, but its location has not been decided.

Ghawar is now supplying more than half of Aramco's total output. In addition to the 200,000 bbl. daily through the 30 and 31-in. line, another approximately 225,000 bbl. daily is being moved out of the three northern Ain Dar separator plants through an older 20, 22, and 24-in. line which extends east into Abqaiq. The total from Ain Dar and Uthmaniyah is about 425,000 bbl. daily. For its remaining production, Aramco is drawing 280,000-290,000 bbl. daily from Abqaiq, 40,000 bbl. daily from Qatif, and 65,000 bbl. daily from Dammam.

The company also is moving ahead steadily with development of the offshore Safaniyah field, a 1951 discovery located on and off the shore of the Persian Gulf near the Neutral Zone border. There are 11 completed Safaniyah wells, all but two of them offshore. The company has no definite plans at this time to produce the field.

Another major Aramco project, the pressure-maintenance program for Abqaiq, is well under way. These facilities, which will return more than 150,000,000 cu. ft. of gas daily to the reservoir, are expected to be completed toward the end of this year. All equipment is in the field, and some of it installed. Total cost of this program is in excess of $20,000,000.

# Iranian Oil Moving

## Two tankers load cargoes at Abadan as Italian exporters capitalize quickly on court victory over Anglo-Iranian

**Dahl M. Duff**

INDEPENDENT Italian exporters last week were following up quickly their initial court victory over Anglo-Iranian Oil Co., Ltd., in the company's legal fight against Iranian oil shipments.

The tanker Miriella loaded another cargo at Abadan for the Supor company of Rome, while the considerably larger Alba prepared to take on a load of more than 80,000 bbl. The head of the Italian Epim company was in Teheran arranging for other shipments by this company.

The decision the previous week by an Italian court at Venice denying Anglo-Iranian's application to impound the Miriella's first shipment was hailed as a momentous event in the Iranian capital. Anglo-Iranian was contesting the ownership of the oil in further legal proceedings in Rome, but a company spokesman conceded it may be months or even years before a decision is given.

To show their gratitude, Iranian officials in a formal government communique said the Supor company would be sold all the oil it could take during the next 6 months at half the world price. For crude oil, the going price in the Persian Gulf is now $1.75 a barrel for 36° gravity, and the 50 per cent discount gives Supor an f.o.b. price of 87½ cents. Previously Iran was reported to be selling crude to these Italian companies at about $1.18 a barrel.

The only question legally before the Venice court was whether the approximately 31,000 bbl. carried by the Miriella should be held under court order until the broader issue of ownership was settled. The Italian judge found there was not sufficient evidence to show the oil was taken without compensation. He cited the fact that Iran's 1951 nationalization law contains a provision to compensate the company out of 25 per cent of the total revenue. However, except for internal consumption, Iran made no sales before the exports to Italy.

**Threat to prices? . . .** The question facing the oil industry last week was how much of a threat the 50 per cent discount offers to the present price

structure in the Persian Gulf. The fact that the offer was limited to 6 months shows that the Iranian Government—the same as other producing countries in the Middle East—is not anxious to destroy the existing price level on which its future revenue depends.

However, if substantial quantities of under-priced Iranian crude can be moved into the Italian market, further cuts in products prices in Italy are possible. Whether this would bring down the Persian Gulf crude price is problematical. Even before the Italian shipments of Iranian crude, there has been some downward pressure on the crude price because of heavy production, slackening demand and other factors.

Last week in Teheran, Count Della Zonca, head of the Epim company, described a scheme under which cargoes of Iranian oil will be brought to the free port of Venice, taken in transit in Italy for refining, and exported to Switzerland. Such a move avoids embarrassing the Italian Government in its British-United States relations by asking an Italian import license.

**Troubles in Italy . . .** The current interest of these unaffiliated Italian companies in Italian oil is explained in part by conditions in Italy's own oil industry. The refining industry in Italy is considerably overbuilt for present needs and is running far below capacity. Further, unlike France, for example, Italian refiners include a large number of local operators of small plants. Out of a total Italian refining capacity of about 250,000 bbl. daily, some 70,000 bbl. daily is owned by companies not affiliated with any of the large international groups.

Reports indicate the firms exporting Iranian oil have what amount to processing deals with some of these unaffiliated Italian refiners. If the volume involved becomes great enough, the price of the products might be cut to find sufficient markets outside Italy. Under such circumstances, the repercussions could become serious since the international companies undoubtedly would meet or better this price competition.

## Turkey Approves Oil Search

Standard Oil Co. (N. J.) has received authorization from the Turkish Government to carry out geological reconnaissance work in that country.

Jersey Standard said its decision to investigate Turkish prospects was in line with a long-standing policy of concentrating in countries "where governments are seriously interested in development of natural resources through private enterprise."

The company is one of several preparing to enter Turkey under the government's new policy of encouraging foreign oil capital. The policy has been approved by the government. The next step is action by the Parliament on favorable petroleum legislation.

# LATIN AMERICA

## Ganso Azul Head Named

Reuben M. Hurt has been made general manager of Ganso Azul Cia. de Petroleo, which carries on a small integrated operation east of the Andes in Peru.

R. M. HURT

Hurt formerly was with International Petroleum Co., Ltd., for 16 years in Ecuador and Colombia. He subsequently went to work for Carter Oil Co. in Mississippi and Louisiana and then became an independent contractor in Farmington, N. M. His headquarters will be in Lima, Peru. The company's operations are conducted near the town of Pucallpa in eastern Peru.

Texas Gulf Producing Co., Houston, recently announced it had completed negotiations with the majority Ganso Azul stockholders whereby a newly formed Peruvian subsidiary will acquire substantially all the outstanding Ganso Azul stock. Texas Gulf Producing will have a 6 per cent participation with the remaining interest held by other United States oil companies.

## Plant Announcement Expected

The Puerto Rican Development Bank is expected to announce a $3,600,000 loan in the near future to Cosden Petroleum Co. for the construction of a new refinery of about 10,000-bbl.-daily capacity in the suburbs of Catano on the south side of San Juan Bay.

Reports from San Juan are that the bank made the loan contingent on a favorable report on the economics of the project in a study by Walter J. Levy, New York economist. This report is understood to be practically finished with a recommendation that the undertaking be carried out.

Cosden is backed by Gulf Oil Corp., according to the San Juan reports. Gulf presumably would furnish Venezuelan crude for the plant. Also associated in the project are Pontiac Refining Co., Corpus Christi, Tex., and the J. H. Whitney financial interests of New York.

The refinery project is linked with the award scheduled for April 1 by the Puerto Rico Water Resources Authority of a 10-year contract for its supply of fuel oil. The authority is the largest fuel-oil consumer on the island and an important outlet for this production from the contemplated refinery.

The Standard Oil Co. (N. J.) organization has been reported to be considering a refinery in Puerto Rico. Another refinery project for the island has been advanced by Lyford & Eberle of New York.

# International Briefs

**The first test by Gulf Exploration** Co. on its concession in Barbados, British West Indies, is now drilling below 3,500 ft. The well is located in the Turner Hall area. This programmed deep test is being drilled with a National 130 rig moved from Cuba where Cuban Gulf Oil Co.'s drilling program has been interrupted pending further study. Gulf obtained a concession covering about half the 166-sq. mile area of Barbados in 1950.

**A wildcat test is being undertaken in** the Bekaa Valley area east of Beirut in Lebanon. The well is being drilled by Santa Fe Drilling Co. with others, said to include Pacific Western Oil Co. The location is near the Village of Yuhmur about 30 miles south of Zahle. Another area to the north is held under concession by the German company, International Tiefbohr, of Celle, and Cie. Lebanese des Petroles.

**The Japanese company, Teikoku Oil** Co., has announced plans to spend some 50 million yen, or about $1,400,000, on development and further exploration work in the vicinity of Horiuchi Village in the Mogami area, Yamagata Prefecture, Japan. A well drilled by the company found production at a depth of about 1,560 ft. Most of Japan's present small production comes from a number of old fields in this basin along the western side of northern Honshu.

**A new 14-mile, 5-in. crude line has** been completed by Emsland-Erdoelleitung, G.m.b.H., to the new refinery at Lingen-Holthausen in the Emsland region of West Germany. The line originates at a central pump station at Osterwald near Georgsdorf. The pumping equipment provides for a throughput of about 13,000 bbl. daily. The regular movement of crude from Emlichheim, Georgsdorf, Ruehlertwist, and Scheerhorn fields to the refinery was scheduled to begin in early March.

## New A.A.P.G. Head

### John Adams to take over duties following meeting

JOHN EMERY ADAMS, who will assume the presidency of the American Association of Petroleum Geologists this week, is a senior geologist for Standard Oil Co. of Texas at Midland.

The A.A.P.G.'s 38th annual meeting is being held in conjunction with that of the Society of Exploration Geophysicists and the Society of Economic Paleontologists and Mineralogists in Houston March 23-26. Adams will take over his duties at the close of the meeting.

Adams was vice president of the A.A.P.G. in 1950-51 and at present is a member of the advisory committee on radioactive-mineral exploration. He was on the association's distinguished-lecturer program in 1944.

He also is a fellow of the Geological Society of America and a past president and past vice president of the West Texas Geological Society. He has served as a guide leader on many organized field trips of the society and has published extensively on the geology of West Texas and southeastern New Mexico.

A native of Iowa, he received bachelor's and master's degrees from the University of Iowa and has done graduate work at the University of Chicago, University of Wisconsin, and University of Texas. During the early years of his career he served as instrument man on an Oklahoma survey party for Roxana Petroleum Corp. (which was later incorporated into Shell Oil Co.) and as a biology instructor at Texas A. & M. College.

In 1927 he became a subsurface geologist and stratigrapher for The California Co. at Colorado City, Tex. He was shifted to Standard Oil Co. of Texas in 1937 and since then has worked in Texas, Louisiana, and New Mexico. Since 1947 he also has acted as exploration consultant for California Research Corp.

**W. I. Woodson** has resigned as general manager of Texas Petroleum Co.'s Venezuelan division at Caracas and as president of S. A. Petrolera Las Mercedes. He will continue to reside in Venezuela, where he will go into business for himself. He also has been retained as a consultant for both companies. **J. R. Carroll,** senior assistant manager of the Texas Petroleum and minor subsidiaries, will succeed Woodson in both positions.

**R. E. Clark,** reservoir engineer for Shell Oil Co., has been transferred from Midland, Tex., to The Hague. **R. E. Gorman,** Shell production foreman, has been transferred from Wasson to Paducah, Tex.

**Herman E. Nichols, Jr.,** has been named exploration manager in charge of all land and geological activities of

H. E. NICHOLS

R. W. STROUD

Warren - Bradshaw Exploration Co. at Tulsa. He formerly was chief geologist for Howell, Holloway & Howell, Dallas, and prior to that was in charge of the geological department of Gulf Oil Corp. at Ardmore, Okla. **Robert W. Stroud,** who formerly was associated with Kirkpatrick Oil Co., has been appointed Oklahoma district geologist for Warren-Bradshaw.

**A. J. Wood,** manager of the gas department at Shell Oil Co.'s Wood River, Ill., refinery, has been promoted to manager of the alkylation department. He has been succeeded by **W. S. Myers,** formerly assistant manager of the catalytic cracking department at the Norco, La., refinery.

**Stephen A. Park,** engineer-clerk for Kewanee Oil Co. at Walters, Okla., has been promoted to junior engineer at Healdton, Okla.

**Walter L. Erwin,** geologist for Sun Oil Co., has been transferred from Abilene, Tex., to Tallahassee, Fla.

R. M. HART

**Ray M. Hart,** Mattoon, Ill., has been appointed assistant to the president of Carter Oil Co. Hart began his career with Carter as a surface geologist 18 years ago and was transferred to Mattoon 2 years ago as manager of exploration for the eastern division. He is taking a leave of absence from that position to accept his new post. **W. W. Turnbull,** eastern division geologist at Mattoon, has been acting manager of exploration, and **J. E. Lewark,** Mattoon, has been appointed acting division geologist.

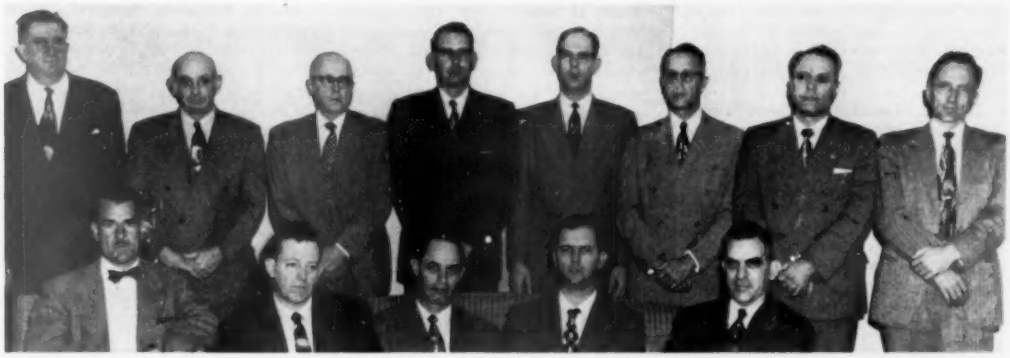
**Dr. K. E. Marple** has been appointed manager of the Denver laboratory of Shell Development Co.'s agricultural research division. He formerly was acting department head of the Emeryville, Calif., research center, and has been at Denver on temporary assignment since May 1952.

**Herman Aweas,** who has been associated with Helmerich & Payne, Inc., Tulsa, for 19 years, has been elected vice president in charge of drilling. Other vice presidents elected include: **Henry Saye,** in charge of production; **Dee A. Sikes,** in charge of drilling contracts and public relations; **Harold E. Tips,** in charge of the land department; and **Erik K. Waering,** in charge of exploration.

**Cecil H. Phillips,** formerly area drilling superintendent for Shell Oil Co. in the Calgary area, has been transferred to Tulsa. He replaces **S. B. Deal,** who has been transferred to the Calgary area.

**C. O. Hopper** has been named field superintendent for Stanolind Oil & Gas Co.'s Canadian division. He joined Stanolind in 1947 and served in various engineering capacities in Texas before his transfer to the Canadian division last July. Stanolind's Canadian operations now cover Alberta and parts of Saskatchewan and British Columbia.

# PERSONALS



## Geological Steering Committee

**These men are members of the steering committee of the Gulf Coast Association of Geological Societies, who met in Houston recently to initiate plans for the third annual fall meeting in Shreveport next October 21-24. Seated, left to right, are: Jack Carlson, editor, Union Oil Co. of California, Tyler, Tex.; W. M. Chaddick, Jr., past chairman, Sun Oil Co., Corpus Christi; D. D. Utterback, vice chairman, Freeport Sulphur Co., New Orleans; George M. Jenkins, chairman, La Gloria Corp., Shreveport; J. S. Spencer, secretary, General Geophysical Co., Houston. Standing, left to right, are: Hastings Moore, consultant, Henderson, Tex.; L. R. McFarland, Magnolia Petroleum Co., Jackson, Miss.; W. A. Thomas, Ohio Oil Co., Houston; J. K. Larsen, Shell Oil Co., Baton Rouge, La.; W. J. Nugent, Pure Oil Co., Shreveport; Hillard W. Carey, Houston Natural Gas Corp., Corpus Christi; H. C. Reichert, Gulf Refining Co., Lake Charles, La.; W. A. Petersen, Continental Oil Co., Corpus Christi. Not present for the picture was Fred Bates, Bates & Cornell, Lafayette, La.**

**C. A. L. Hogg,** deputy minister of natural resources in Saskatchewan, will become deputy minister of mineral resources April 1. The experiment will enable him to devote his undivided attention to matters pertaining to the province's expanding petroleum and mining industries.

**R. E. Kellerman,** division engineer for Texas Crude Co. at Midland, Tex., has been promoted to chief engineer at Fort Worth.

**Lester Marshall,** geologist for Devonian Co. at Tulsa, has been appointed a geologist for Warren Petroleum Corp. at Denver.

**Dr. Arno C. Fieldner,** chief fuels technologist for the U. S. Bureau of Mines, is slated to receive the second annual Honor Award of the Washington, D. C., chapter of the American Institute of Chemists. The presentation will be made at a dinner in the Roger Smith Hotel April 7.

**Walter R. Fillippone,** recently in charge of Alaskan operations for United Geophysical Co., Inc., has been appointed area operations manager for the Rocky Mountains and Williston basin. **Flint H. Agee,** who has been associated with United since 1945 as party chief and supervisor of California seismic and water parties, has been appointed West Coast area manager. Agee will continue to make his headquarters in Pasadena, Calif.

**J. R. Dorrance** has been promoted to assistant Pacific Coast division manager for The Texas Co., effective April 1. **H. F. Ashauer** will replace Dorrance as division geologist on that date.

R. C. CURTIS

**R. C. Curtis** has been appointed production superintendent for Carter Oil Co.'s northern production division to be activated April 1. Headquarters will be in Billings, Mont. Assisting him will be: **Harry E. Allen,** Oklahoma City, as division engineer; **George Richardson,** Carmi, Ill., as district foreman at Miles City, Mont.; **George A. Trimble,** Cut Bank, Mont., as development foreman at Wolf Point; and **Fred Hill,** Merino, Colo., as development foreman at Sheridan, Wyo. The northern production division includes operations in Montana, North and South Dakota, Washington, Oregon, and northern Wyoming and Idaho.

**Henry J. DeLaune** has been named chief geologist for Petersen Drilling Co. at Shreveport. For the past 5 years he has been affiliated with the geological department of Sohio Petroleum Co.

**E. M. Brown,** formerly general superintendent for Mazda Oil Corp. at Tulsa, has been named superintendent of drilling and production for San Juan Oil Co. and San Juan Exploration Co. at Dallas.

**Paul J. Shanor,** formerly a petroleum engineer for the Illinois State Geological Survey at Urbana, has been appointed an engineer for Bradley Producing Corp. at Tulsa.

**J. M. Hansell,** chief geologist for the Rocky Mountain division of Sun Oil Co., has returned to work at Denver following several months on sick leave.

**Raymond E. Poppe,** engineering trainee for Sohio Petroleum Co., has been transferred from Pauls Valley to Edmond, Okla.

**T. L. Huddleston,** formerly district production engineer for Lone Star Gas Co. at Snyder, Tex., has been named district scout for West Texas and New Mexico at Midland, Tex.

**Carl H. Gullick,** seismograph party chief for Continental Oil Co., has been transferred from Fort Stockton to Big Spring, Tex.

**Jack W. Grigsby** has resigned, effective April 1, as chief division geologist for Midstates Oil Corp., at Shreveport to become an independent. He has

# PERSONALS

been with Midstates the past 8 years and prior to that worked in the production department of Arkansas-Louisiana Gas Co. in Shreveport.

**Jack Q. Tomkins** has been named West Texas-New Mexico district geologist for Mid-Continent Petroleum Corp. He formerly was with Wilshire Oil Co., Inc., in California and Midland, Tex. He will be located in Mid-Continent's Midland office.

**Gavin H. D. Martin** has been appointed chief engineer for Union Gas Co. of Canada, Ltd., at Chatham, Ont. He is a graduate of Toronto University and has been head of the Union engineering department since 1948. In his new post he will coordinate all operating departments dealing with the production, transmission, and distribution of gas.

**E. F. Bullard,** president of Stanolind Oil & Gas Co., Tulsa, has been elected to the board of directors of the First National Bank & Trust Co., Tulsa. **Frank O. Prior,** executive vice president of Standard Oil Co. of Indiana, has resigned as a board member.

**Hollis D. Immick,** vice president and director of Inter-State Oil Co., Kansas City, has succeeded the late C. A. Shepard as president. Prior to joining Inter-State he was president of Immick Co., a general contracting organization.

**Walton H. Hohag, Jr.,** has been elected a director, vice president, and general manager of operations for Banff Oil, Ltd., engaged in exploration and development in western Canada. He formerly was director and vice president of Socony-Vacuum Exploration Co., and also manager of exploration for that company the past few years.

**James E. Spurgin,** driller for Big West Drilling Co., has been transferred from Carlsbad, N. M., to Odessa, Tex.

**Pierson M. Ralph,** party chief for Geophysical Service, Inc., has been transferred from Riverton to Greybull, Wyo.

**Joe B. Buchanan,** formerly division manager in Midland, Tex., for Al Buchanan Drilling Co.'s operations in West Texas and Southeast New Mexico, has been appointed contact man for Robinson Brothers Drilling Co. in Midland.

**Norman W. Krouskop,** assistant superintendent for General American Oil Co. of Texas at Artesia, N. M., has been promoted to district superintendent at Worland, Wyo.

**Dr. John A. Hipple,** chief of the atomic section, National Bureau of Standards, Washington, D. C., has been named director of the Mineral Industries Experiment Station at Pennsylvania State College. He fills the vacancy created by the retirement of **Dr. Alfred W. Gauger.**

**J. P. Warner,** general superintendent at Esso Standard Oil Co.'s Baton Rouge, La., refinery, has been promoted to assistant general manager of the Louisiana Manufacturing division. He succeeds **Charles Leet,** now manager of the Bayonne, N. J., refinery.

# DEATHS

**Frank Garfield McClintock,** 89, died March 16 in Tulsa. He became associated with the oil industry in Ohio, and moved to Independence, Kans., in 1903. He became superintendent of production for A. W. Shulthis of Independence in 1907 and was with Shulthis until his retirement in 1935. He was the grandfather of Frank C. McClintock, president of Zephyr Drilling Corp.

**William Reid Hamrick,** 51, assistant superintendent for Atlantic Pipe Line Co., died of a heart attack March 14 at his home in Royalty, Tex.

**C. A. Miller,** drilling superintendent for Kerr-McGee Oil Industries, Inc., in the Rocky Mountains, died recently in Casper, Wyo.

**W. B. Sole,** 75, drilling contractor, died recently in Bristow, Okla.

**Lewis E. Spear,** 85, pioneer California oil-well equipment manufacturer, died recently in Santa Barbara, Calif. He was president of Pacific Wire Rope Co., Los Angeles.

**Cadmus McCall,** 77, who entered the oil business in partnership with Phil Lesh in 1926, died recently in Nocona, Tex. He also was a banker and cattleman.

**J. P. West,** 57, Pampa, Tex., oil operator, died in a Tulsa hospital March 17.

**Nathan J. Brown,** 61, superintendent for The Texas Co. terminal division at Port Arthur, Tex., died there recently.

**E. C. McGurren,** 46, Chicago division manager for Skelly Oil Co., died in Chicago March 11 of a cerebral hemorrhage.

**Ward J. Shelton,** 78, pioneer in the Texas oil industry, died at his home in Electra, Tex., March 15. He took part in the sale of the 110,000-acre Waggoner-Colony estate and in the development of Spindletop field. His later activities included work on the Goose Creek, Thrall, Mexia, Coleman, and Burkburnett fields.

**Joseph Frystock,** 57, formerly an engineer for Esso Standard Oil Co. at its Bayway refinery at Linden, N. J., died March 15 at his home in Linden.

**Timothy L. Padden,** 77, Sapulpa, Okla., retired compressor station superintendent for Oklahoma Natural Gas Co., died in Tulsa March 14.


## Free Reprints of "Multicomponent Distillation"

Because we feel this guide to multicomponent distillation is of special value to engineers engaged in processing petroleum, we will send you a reprint free on request. Write Reader Service Department, P. O. Box 1260, Tulsa 1, Oklahoma. From 2-99 copies are 20 cents each; 100-249 copies are 15 cents each; over 250 are 10 cents each.

# WHAT'S HAPPENING IN REFINING . . .

## A SPECIAL SECTION OF 90 PAGES

### 1. Multicomponent Distillation—A condensed manual

The engineer who encounters multicomponent distillation for the first time is overwhelmed by the voluminous amount of seemingly unrelated published material on this subject. The various articles seem to be a conglomeration of refinements and extensions of methods of calculation that are known only to the experts in this field. Far too little attention has been given to the task of evaluating what is available and preparing a comprehensive outline of how best to approach the general problem. This section fulfills just this purpose. The article begins with the fundamentals of vapor-liquid equilibria, continues with ideal and nonideal solutions, presents proper nomenclature, and then dwells at some length on the various straightforward, short-cut, and algebraic methods of solution of multicomponent distillation problems.

### 2. Maintenance for Profit—How to get the job done

Here are articles that tell you how to do your maintenance job more efficiently by outlining (1) how to reduce maintenance costs by looking for new work methods and reducing the plant work load; (2) how to use in-place chemical cleaning in the process plant; (3) how to use mobile equipment in the maintenance program; (4) how a central coordinating committee functions to set up a maintenance priority list; (5) how to evaluate cost of keeping standby equipment in the plant; (6) how to keep track of spare parts; (7) how to employ an acidproof cement lining in a vacuum-flash column, or similar equipment to cut down corrosion; and (8) how to prevent erosion in fluid catalytic cracking equipment.

### 3. New Developments in Processing Petroleum

Articles in this general section deal with (1) Hyperforming, a continuous process for reforming and upgrading of naphtha stocks, employing moving catalyst beds in reactor and regenerator; (2) economic comparison between vacuum flashing, delayed coking, and solvent decarbonizing as alternate methods of preparing catalytic cracker feed stock; (3) how catalyst flow rates are measured by the radioactive tracer method; (4) how to prepare the job schedule when constructing refinery process units; (5) how the engineering contractor functions in building process units; and (6) refinery processing and construction tables showing plant capacities and processes, and units under construction.

THE OIL AND GAS JOURNAL

*Here's what you need to know about*

# MULTICOMPONENT DISTILLATION

*. . . for a general understanding of the subject and as a basis for further study*

by M. Van Winkle

A logical, step-by-step method of approach to the design of multicomponent fractionating equipment is presented here. The author has not attempted to develop any new theories or method of procedure in the evaluation of vapor-liquid equilibria of multicomponent systems, or in the design of fractionating columns. Rather, he has shown how fundamental engineering principles are applied to the over-all problem, and how the various shortcut and more rigorous methods of calculation may be used. When necessary, example calculations are made to illustrate these points. Use of a particular method for an example calculation does not imply that the author considers the method better or more accurate than others that might be used.

THE AUTHOR

**Matthew Van Winkle** is graduate professor and chairman of the department of chemical engineering at University of Texas. He is also active in consulting work in the petroleum-refining field. Van Winkle has been associated with Cities Service Oil & Refining Co., and with Standard Oil Co. of Indiana. He has served on faculties at Pennsylvania State College and University of Michigan. Van Winkle is a member of a number of honorary and professional societies and is a registered professional engineer. He has some 29 previous publications to his credit.

DISTILLATION, or more accurately fractional distillation, is an operation in which a material or component may be separated from other materials or components with which it is associated by means of differences in volatility or effective boiling points. Fractional distillation is probably the most widely used separation method in the petroleum and chemical industries, both from the standpoint of number of applications and the quantities of materials separated.

"Multicomponent" distillation, or "multicomponent" fractional distillation, as discussed here is defined as the separation method for systems containing more than two compounds but containing identifiable compounds. Thus, a system composed of, for example, 10 compounds whose identities are established is considered a multicomponent mixture. On the other hand, a mixture containing a number of unidentifiable components is considered a complex mixture. Petroleum oils or petroleum-oil fractions are nominally considered to be complex mixtures. Quantitative methods used in distillation calculations for each of these types of mixtures are very different.

## Vapor-Liquid Equilibria

All fractionation calculations involve the use of vapor-liquid equilibrium data which relate the vaporization characteristics of compounds in a mixture in the liquid and vapor states with mixture characteristics, temperature, and pressure. Therefore, before a quantitative study of any fractionation operation can be made effectively, it is necessary to have available experimental vapor-liquid equilibrium data on the system to be studied or to have some method of predicting such data from properties of the pure materials. The method must be able to predict the equilibrium data within limits of accuracy imposed by the other methods used in the study.

In general, systems may be classed as "ideal" or "non-ideal."

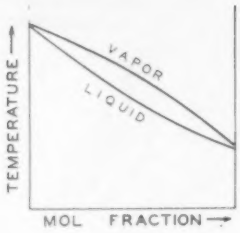



Fig. 1A.

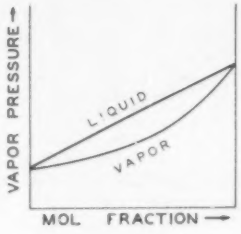



Fig. 1B.

Above are ideal system binary equilibrium curves. At right is a diagram of ideal system ternary isothermal compositions.

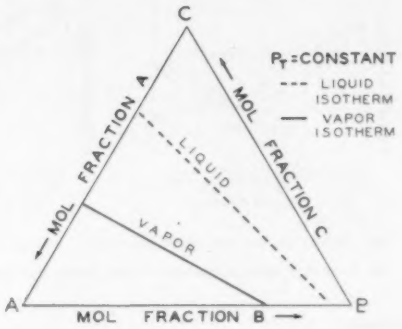



Fig. 1C.

### Ideal Systems

An ideal system may be defined in a number of ways. It is a system in which the vapor and liquid in equilibrium and the components comprising them follow the ideal gas laws (see Equations 3, 4, and 5). If the ratios of vapor pressures of all components to one another remain constant over a temperature range, the mixture is said to be ideal over that range of temperatures. Also, a system is classed as ideal when the activity coefficients of each and all components in the mixture are unity.

Typical ideal systems are shown in Figs. 1a, 1b, and 1c.

**Basic equations:**

$$y_a + y_b + y_c + \ldots\ldots + y_n = 1.0 \quad (1)$$

$$x_a + x_b + x_c + \ldots\ldots + x_n = 1.0 \quad (2)$$

$$p_a + p_b + p_c + \ldots\ldots + p_n = p_t \quad (3)$$

$$y_a P_T + y_b P_T + y_c P_T + \ldots\ldots + y_n P_T = P_T \quad (4)$$

$$x_a P_a + x_b P_b + x_c P_c + \ldots\ldots + x_n P_n = P_T \quad (5)$$

$$\alpha_{ac} = P_a/P_c, \quad \alpha_{bc} = P_b/P_c \quad (6)$$

$$\gamma_a = \frac{y_a P_T}{x_a P_a} = 1.0, \quad \gamma_b = \frac{y_b P_T}{x_b P_b} = 1.0 \quad (7)$$

where:

y = mol fraction of the component in the vapor
x = mol fraction of the component in the liquid
p = partial pressure of the component in the vapor
P = vapor pressure of the component in the liquid
$P_T$ = total pressure on the system
$\alpha$ = relative volatility of the designated component to the other
$\gamma$ = activity coefficient of the component designated (unity for components in ideal systems)
a, b, c, d, n = subscripts referring to components

### Calculation of Ideal Vapor-Liquid Equilibrium Data

To determine the equilibrium data for an ideal multicomponent system it is necessary only to know the temperature-vapor pressure data, the total pressure on the system, and one composition. From Phase Rule,

$V = C + 2 - P = 3$; $P + t + x = 3$, for a ternary.

Thus, for a system of five components:

$$p = Px = yP_T; \quad \Sigma p = P_T = \Sigma Px$$

$$y_a = \frac{P_a x_a}{P_a x_a + P_b x_b + P_c x_c + P_d x_d + P_e x_e} \quad (8a)$$

$$y_b = \frac{P_b x_b}{P_a x_a + P_b x_b + P_c x_c + P_d x_d + P_e x_e} \quad (8b)$$

etc.

$$x_a = \frac{y_a/P_a}{y_a/P_a + y_b/P_b + y_c/P_c + y_d/P_d + y_e/P_e} \quad (9a)$$

$$x_b = \frac{y_b/P_b}{y_a/P_a + y_b/P_b + y_c/P_c + y_d/P_d + y_e/P_e} \quad (9b)$$

In terms of $\alpha$ based on component e):

$$y_a = \frac{\alpha_{ae} x_a}{\alpha_{ae} x_a + \alpha_{be} x_b + \alpha_{ce} x_c + \alpha_{de} x_d + x_e} \quad (10)$$

$$x_a = \frac{y_a/\alpha_{ae}}{y_a/\alpha_{ae} + y_b/\alpha_{be} + y_c/\alpha_{ce} + y_d/\alpha_{de} + y_e} \quad (11)$$

etc.

Thus where the composition of either a multicomponent liquid or vapor is known and temperature of the equilibrium or pressure is known (the other can be calculated) the compositions in the other phase in equilibrium can be calculated from Equation 10 or 11.

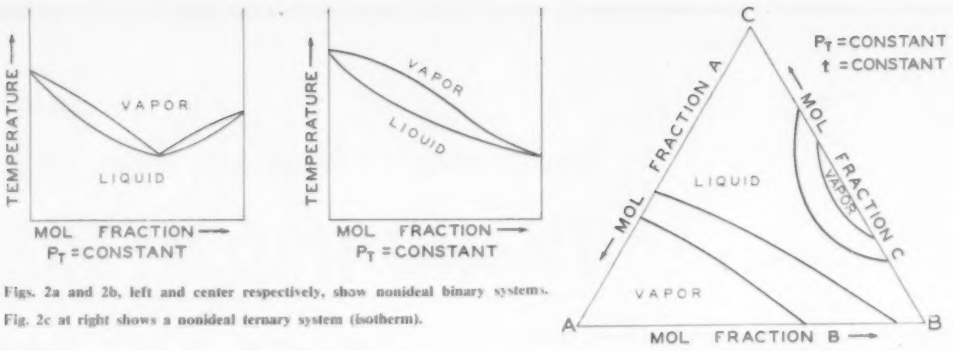
**Example calculations:**

**DATA: SYSTEM—METHANOL, ETHANOL, N-PROPANOL**

| | Vapor pressure, mm. Hg | | |
|---|---|---|---|
| | Methanol | Ethanol | n-Propanol |
| Temp. (°C.) | (a) | (b) | (c) |
| 55 | 501 | 272 | 114 |
| 60 | 620 | 340 | 146 |
| 65 | 765 | 422 | 184 |
| 70 | 930 | 520 | 235 |
| 75 | 1,120 | 645 | 294 |
| 80 | 1,340 | 790 | 368 |
| 85 | 1,600 | 950 | 450 |
| 90 | 1,900 | 1,160 | 555 |

Assume the above system to behave ideally in both vapor and liquid:

1. Calculate the pressure on the system at 80° C., $x_{methanol} = 0.50$, $x_{ethanol} = 0.30$.
2. Calculate the vapor composition in equilibrium with the above liquid.




**Figs. 2a and 2b, left and center respectively, show nonideal binary systems. Fig. 2c at right shows a nonideal ternary system (isotherm).**

**Solution:**

1. $\Sigma(p) = P_T = \Sigma(xP)$; $P_T = x_a P_a + x_b P_b + x_c P_c$

$$P_T = (0.50)\ (1,340) + (0.30)\ (790) + (0.20)\ (368)$$

$$P_T = 670 + 237 + 74 = 981 \text{ mm. Hg} \qquad \text{(answer)}$$

2. $y_a = \dfrac{P_a x_a}{P_a x_a + P_b x_b + P_c x_c} = p_a/P_T$

$$y_a = 670/981 = 0.682 \qquad \text{(answer)}$$

$$y_b = P_b x_b / P_T$$

$$y_b = 237/981 = 0.242 \qquad \text{(answer)}$$

$$y_c = 1 - (y_a + y_b) = 0.076 \qquad \text{(answer)}$$

## Nonideal Systems

Actually, most systems are nonideal and only a few are ideal within the limits of accuracy required for most fractionation calculations. Nonideal behavior may be defined as the opposite of ideal behavior; that is, the system does not obey the ideal gas laws, the ratios of vapor pressures (or relative volatilities) vary with temperature, and the activity coefficients of the components are not unity. Other additional indications of nonideality are: evidence of heat of mixing when the components are combined in the liquid phase and the total volume of the liquid mixture does not equal the sum of the volumes of the individual components.

Typical nonideal systems are shown in Figs. 2a, 2b, and 2c.

**Basic equations:**

$$\gamma_a = \frac{p_a}{x_a P_a} = \frac{y_a P_T}{x_a P_a} \qquad (12a)$$

$$\gamma_b = \frac{p_b}{x_b P_b} = \frac{y_b P_T}{x_b P_b} \qquad (12b)$$

$$\frac{x_a P_a \gamma_a}{y_a} = \frac{x_b P_b \gamma_b}{y_b} = \frac{x_n P_n \gamma_n}{y_n} = P_T \qquad (13)$$

$$\frac{x_a P_a \gamma_a}{P_T} + \frac{x_b P_b \gamma_b}{P_T} + \frac{x_n P_n \gamma_n}{P_T} = 1.0 \qquad (14)$$

$$\frac{y_a P_T}{\gamma_a P_a} + \frac{y_b P_T}{\gamma_b P_b} + \frac{y_n P_T}{\gamma_n P_n} = 1.0 \qquad (15)$$

where:

$\gamma$ = activity coefficient of component in mixture
p = partial pressure of component in vapor
P = vapor pressure of component in liquid
x = mol fraction of component in liquid
y = mol fraction of component in vapor
a, b, n = subscripts denoting components

## Determination of Nonideal Vapor-Liquid Equilibrium Data

Vapor-liquid equilibrium data for a multicomponent system may be obtained in several ways.

1. They can be determined experimentally. For systems composed of four or more components this procedure involves an enormous amount of tedious experimental work.

2. They can be calculated from multicomponent activity coefficient-liquid composition data (if available). This is practical for ternary systems, possible but tedious for quarternary systems, and impractical for systems containing more than four components.

3. They can be predicted from equilibrium vaporization ratio charts (K charts). Where K charts are used it is necessary that the variable of system characteristics be incorporated to obtain the necessary accuracy.

4. They can be predicted from binary activity coefficient-liquid composition plots if temperature-composition data are known. This method is practical for ternary systems but impractical for systems containing a greater number of components.

**Plotting ternary data . . .** A convenient method of plotting ternary data is that used by Griswold and Dinwiddie.[27] The plots consist of two sets of binary equilibrium curves (x-y) with parameters of per cent of third component in the vapor on one set and per cent of third component in the liquid for the other set. Four plots are necessary for the data to be read directly without computation, although two can be used and the other composition calculated. Two such plots are shown in Figs. 3 and 4.

## Calculation from Ternary Activity Coefficient-Liquid Composition Data

Where ternary activity coefficient-liquid composition experimental data are available or they can be mathematically predicted from binary data, the type of plots shown in Fig. 5 is usually used. In these plots lines representing constant values of activity coefficient for each of the components are plotted on separate ternary liquid-composition diagrams. From these plots it is possible to estimate with a fair degree of accuracy the activity coefficients for each of the components at any liquid composition.

The ternary vapor compositions may be completed by trial and error from Equations 16, 17, and 18 and accurate vapor-pressure data on the pure components.

$$y_a = \frac{\gamma_a P_a x_a}{P_T}; \quad y_b = \frac{\gamma_b P_b x_b}{P_T} \qquad (16)$$

$$y_a + y_b + y_c = 1.0 \qquad (17)$$

$$\gamma_a P_a x_a + \gamma_b P_b x_b + \gamma_c P_c x_c = P_T \qquad (18)$$

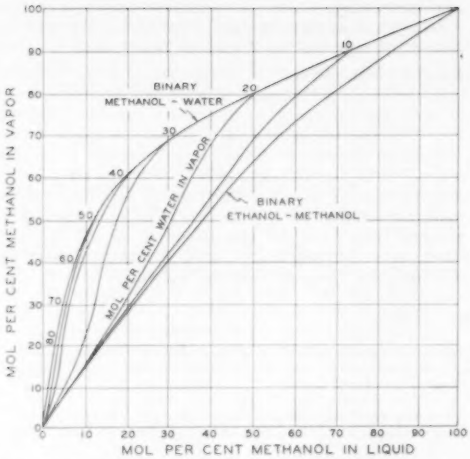

MOL PER CENT METHANOL IN VAPOR
MOL PER CENT METHANOL IN LIQUID
BINARY METHANOL - WATER
BINARY ETHANOL - METHANOL
MOL PER CENT WATER IN VAPOR

Fig. 3—Methanol equilibrium curve for the ternary system, methanol, ethanol, and water.

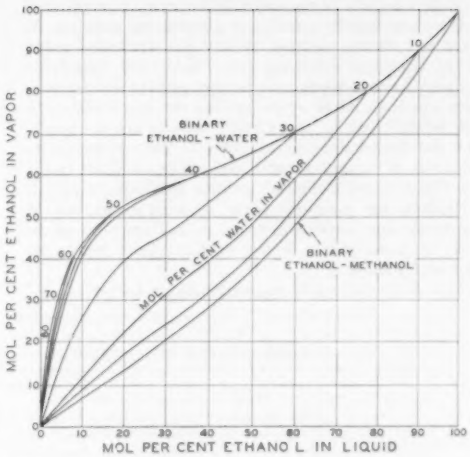

MOL PER CENT ETHANOL IN VAPOR
MOL PER CENT ETHANOL IN LIQUID
BINARY ETHANOL - WATER
BINARY ETHANOL - METHANOL
MOL PER CENT WATER IN VAPOR

Fig. 4—Ethanol equilibrium curve for the ternary system, methanol, ethanol, and water.

This method involves the selection of a trial equilibrium temperature, substituting the vapor pressures (corresponding to this temperature) of the components in Equation 18 and calculating the value of the terms on the left-hand side of the equation. This is repeated until the value equals the total pressure. The vapor compositions are then calculated by Equation(s) 16.

### Equilibrium Vaporization Ratios—K Values

Particularly for hydrocarbon multicomponent systems it is customary to use equilibrium vaporization ratios to describe vapor-liquid equilibria. K values are defined by Equation 19:

$$K = y/x = \gamma P/P_c \qquad (19)$$

Equilibrium vaporization ratios are a function of temperature, system pressure, composition with respect to the component, and system characteristics. The conventional K charts[4,30,33,48a] are for designated components in a specified molecular-weight mixture and are plotted as functions of temperature and pressure. Most of these charts have been calculated from fugacity relations wherein ideality of the liquid phase was assumed; i.e., $\gamma = 1.0$ but deviation from ideality in the vapor phase was corrected for through compressibility factors. While the K charts of Brown[4] and Katz[30] were specifically indicated to be valid for particular mixture properties (molecular weights) many K charts have been devised with little or no attempt to correct for variable composition and mixture properties other than in a general manner. Hadden[28] and Winn[61] have produced charts for hydrocarbons in which the variable of system characteristics has been included through convergence pressure of the system.

Examination of Equation 19 indicates that K values are a function of activity coefficients which are an indication of nonideality. Activity coefficients are unity for the pure compound and deviate from unity as the concentration of the component becomes smaller, reaching the greatest deviation at infinite dilution. In systems containing only paraffin hydrocarbons the components can be considered to form ideal solutions and concentration will therefore have no effect on the K value. Where mixtures of hydrocarbon types are encountered, the assumption of ideal solution cannot safely be assumed. The author[58] found deviations in average K values of the components of binary mixtures of high boiling paraffins and olefins at subatmospheric pressures amounting in some cases to 5 per cent. This deviation was the result of varying mixture characteristics and some solution nonideality.

### Prediction of Ternary Vapor-Liquid Equilibria from Binary Activity Coefficient-Liquid Composition Relations

In many cases it is possible to predict ternary activity coefficient-composition curves from the activity coefficient-composition data on the three possible binary systems from the components in the ternary. Commonly the

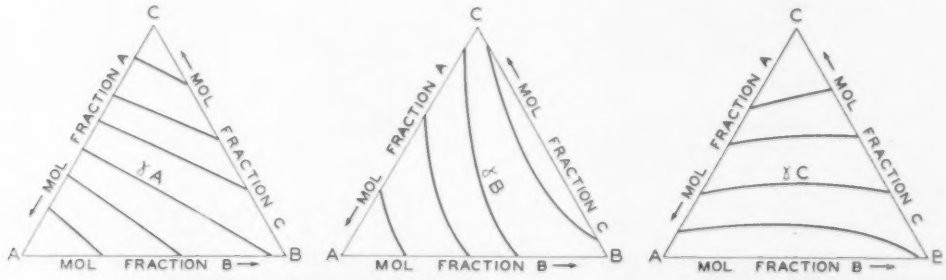



Fig. 5—Ternary activity coefficient-composition curves.

van Laar solutions of the Gibbs-Duhem equation are used to relate the activity coefficient-composition data on the binary and ternary systems. Wohl[62] has developed a system of equations involving two, three, and four-suffix relations. Some systems can be described with the two-suffix equations while others require the four-suffix type. Both White[59] and Li and Coull[39] include activity coefficient and temperature as variables in their relations for evaluation of ternary vapor-liquid equilibria from binary data. Carlson and Colburn[12] predict approximate activity coefficients for components in a ternary mixture by logarithmic interpolation in terms of mol fractions of the other two components in the mixture (from binary activity coefficients).

The Wohl two-suffix equations are as follows:

**COMPONENTS 1, 2, AND 3**

$$\log \gamma_1 = \frac{x_2^2 A_{12} (A_{21}/A_{12})^2 + x_3^2 A_{13} (A_{31}/A_{13})^2 + x_2 x_3 (A_{21}/A_{12}) (A_{31}/A_{13}) [A_{12} + A_{13} - A_{32} (A_{13}/A_{31})]}{[x_1 + x_2 (A_{21}/A_{12}) + x_3 (A_{31}/A_{13})]^2} \quad (20a)$$

$$\log \gamma_2 = \frac{x_3^2 A_{23} (A_{32}/A_{23})^2 + x_1^2 A_{21} (A_{12}/A_{21})^2 + x_3 x_1 (A_{32}/A_{23}) (A_{12}/A_{21}) [A_{23} + A_{21} - A_{13} (A_{21}/A_{12})]}{[x_2 + x_3 (A_{12}/A_{23}) + x_1 (A_{12}/A_{21})]^2} \quad (20b)$$

$$\log \gamma_3 = \frac{x_1^2 A_{31} (A_{13}/A_{31})^2 + x_2^2 A_{32} (A_{23}/A_{32})^2 + x_1 x_2 (A_{13}/A_{31}) (A_{23}/A_{32}) [A_{31} + A_{32} - A_{21} (A_{32}/A_{23})]}{[x_3 + x_1 (A_{13}/A_{31}) + x_2 (A_{23}/A_{32})]^2} \quad (20c)$$

where:
$\gamma$ = activity coefficient (ternary)
$x$ = mol fraction in liquid (ternary)
1, 2, 3 = subscriptions denoting component

$A_{12}$ = van Laar constant A for binary 1-2
$A_{21}$ = van Laar constant B for binary 1-2
$A_{13}$ = van Laar constant A for binary 1-3
$A_{31}$ = van Laar constant B for binary 1-3, etc.

Van Laar binary equations:

$$A = \log \gamma_1 [1 + (x_2 \log \gamma_2)/(x_1 \log \gamma_1)]^2 \quad (21a)$$

$$B = \log \gamma_2 [1 + (x_1 \log \gamma_1)/(x_2 \log \gamma_2)]^2 \quad (21b)$$

Thus with the van Laar constants known for the three binary systems the $\gamma$ values for each component in the ternary mixture can be calculated and from the $\gamma$'s the y's can be obtained by Equation 19.

### Fractionating-Column Design

**Determination of equilibrium stages . . .** In the fractionating distillation process the quality or specified concentration of the products obtained in the separation depends largely on the number of contact or "equilibrium" stages used in the fractionating column. The economics of the fractionation process involve the evaluation of number of equilibrium stages at various reflux ratios and the resultant operating and investment costs. Plots of the two types of cost on the same scales will indicate an optimum.

**General considerations . . .** Examination of the variables in a fractionating distillation indicate two theoretical limits of operation. Referring to the binary Ponchon diagram, Fig. 6, as the reflux ratio is increased the upper difference point increases in value on the enthalpy scale until at total reflux the point is at infinity. The operating line or material-balance lines become vertical and the absolute minimum number of equilibrium steps are required to progress from $x_4$ to $x_5$. This is shown on the McCabe-Thiele type diagram, Fig. 7, as the condition where the operating line coincides with the line where $x = y$. Thus one limit of theoretical operation is at **total reflux** and **minimum stages.**

Again referring to the binary Ponchon diagram, Fig. 8, as the reflux ratio is decreased the upper difference point decreases in value with respect to the enthalpy scale until a point is reached where the operating line drawn through the difference point coincides with an equilibrium tie line. Under this condition an infinite number of stages will be required to obtain a separation.

On the McCabe-Thiele diagram, Fig. 9, the condition is represented by the operating line becoming tangent to or intersecting the equilibrium line. This is the limiting condition of **minimum reflux** or **infinite stages.**

Practically the operating range of a fractionating column is intermediate to the two limiting conditions. While operation at high reflux ratios reduces the number of stages, the operating cost becomes prohibitive. On the other hand, low reflux ratios increase the number of stages necessary and therefore increase the investment costs.

**Fig. 6—Enthalpy-concentration diagram for total reflux.**

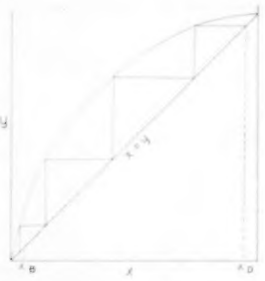



**Fig. 7—McCabe-Thiele diagram for total reflux.**

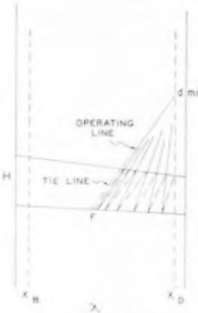



**Fig. 8—Enthalpy-concentration diagram for minimum reflux.**

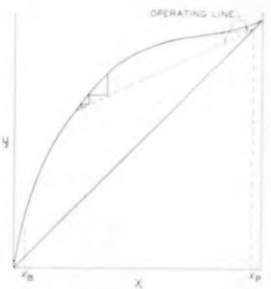



**Fig. 9—McCabe-Thiele diagram for minimum reflux.**

It is possible to operate an experimental column at total reflux. It is impossible to operate a column at minimum reflux. Therefore, the use of the limiting conditions to evaluate practical operating reflux ratios and equilibrium stages is based on hypotheses incapable of experimental proof.

In the case of binary mixtures it is possible graphically to determine the minimum reflux ratio by extension of tie lines (on the Ponchon diagram) to locate the difference point giving minimum-minimum reflux. This tie line may lie through the feed, above, or below it, giving rise to the conclusion that only one zone of constant composition or "pinch" zone is encountered in a binary system.

In the case of a multicomponent system with more than three components it is postulated that **two** zones of constant composition or pinch zones are encountered at minimum reflux—one above and one below the feed plate.

With ternary systems it is possible to conceive of a

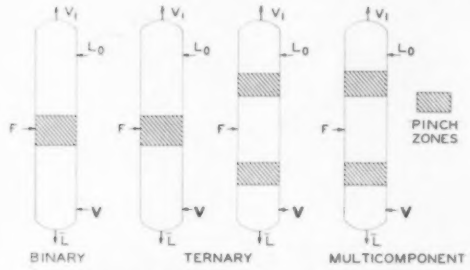



**Fig. 10—Location of pinch zones at minimum reflux.**

single zone of constant composition at the feed plate under some conditions and two zones of constant composition, one above and one below the feed plate, under other conditions. Graphical or mathematical proof of either one or the other is not available.

**Variables in fractionating column design . . .** A critical analysis of fractionating columns will indicate that the greatest possible number of variables that can be fixed to fix the operation of the column is:

$$V = C + 5 \qquad (22)$$

where:

V = number of variables (composition, temperature, pressure, number of stages, reflux ratio, etc.)
C = number of components

when the assumption of no heat loss from the column to the surroundings is included.

Considering a three-component system, C= 3. Therefore, according to the rule:

$$V = 3 + 5 = 8$$

Normally the following are fixed from practical considerations:

| | |
|---|---|
| Feed (2 compositions) | 2 |
| Feed (1 enthalpy) | 1 |
| Distillate (1 composition) | 1 |
| Bottoms (1 composition) | 1 |
| Temperature (reflux) | 1 |
| Pressure | 1 |
| Total | 7 |

One remaining variable must be fixed to fix the operation. The two remaining are operating reflux ratio, L/D, and number of stages. Usually L/D is fixed and the number of stages corresponding to this value of L/D selected are calculated.

For a six-component system, V = 6 + 5 = 11:

| | |
|---|---|
| Feed (5 compositions, enthalpy) | 6 |
| Distillate (1 composition) | 1 |
| Bottoms (1 composition) | 1 |
| Temperature (reflux) | 1 |
| Pressure | 1 |
| L/D | 1 |
| Total | 11 |

It is common practice to follow the stepwise procedure given below in determining the number of equilibrium stages needed.

1. Determine the feed composition to the column.
2. Determine the thermal condition of the feed.
3. Establish the composition of the distillate with respect to the lighter key component.
4. Establish the composition of the bottoms with respect to the heavier key component.
5. Establish the temperature at the condenser.
6. Establish the pressure on the column.
7. Fix the operating reflux ratio, L/D.
8. Calculate the number of equilibrium stages needed.

### Methods of Determining Equilibrium Stages

**General procedure . . .** In the design and study of fractionation columns it is recommended that the limit conditions be evaluated first and then the actual operating condition of reflux ratio and number of stages: (a) minimum stages—total reflux, (b) minimum reflux—stages, (c) theoretical stages—operating reflux.

The accompanying tabular outline lists the possible methods used in evaluating these conditions:

**EVALUATION METHODS**

| | Applicable to . . . System |
|---|---|
| Minimum stages: | |
| 1. Algebraic—"Exact plate to plate" | Ternary, multicomponent |
| 2. Algebraic—Short cut | Ternary, multicomponent |
| 3. Graphical | Ternary |
| Minimum reflux: | |
| 1. Algebraic—"Exact plate to plate" | Ternary, multicomponent |
| 2. Algebraic—Short cut | Ternary, multicomponent |
| 3. Graphical | Not applicable |
| Theoretical stages at operable reflux: | |
| 1. Algebraic—"Exact plate to plate" | Ternary, multicomponent |
| 2. Algebraic—Correlation of limiting conditions with operating conditions | Ternary, multicomponent |
| 3. Graphical | Ternary |

**Preliminary calculations . . .** Note: Because of the extensive amount of discussion necessary to consider all of the possible methods mentioned above, a simple ternary system will be used in the example calculations. This system is the ternary: methanol, ethanol, propanol.

**Example:** Given—ternary system of the following composition:

| | Feed |
|---|---|
| $x_{methanol}$ | 0.22 |
| $x_{ethanol}$ | 0.18 |
| $x_{propanol}$ | 0.60 |

Feed—saturated liquid.
Pressure—20 psia.
Distillate product required—99.5 wt. per cent methanol.
Recovery—99.9 wt. per cent of methanol in distillate
Total condenser, reflux at bubble point.

Find the number of theoretical fractionation stages necessary to make the separation required.

**Solution:** Determine composition of distillate and bottoms. Material balance: Basis, 1 mol feed.

| | Feed | | |
|---|---|---|---|
| | Mol (%) | MW | Lb. |
| L.K.—methanol | 22.0 | 32 | 7.05 |
| H.K.—ethanol | 18.0 | 46 | 8.38 |
| propanol | 60.0 | 60 | 36.00 |
| | | | 51.43 |

| | Distillate | | |
|---|---|---|---|
| | Lb. | Wt. (%) | Mol (%) |
| L.K.—methanol | 7.040 | 99.5 | 99.7 |
| H.K.—ethanol | 0.035 | 0.5 | 0.3 |
| propanol | | | |
| | 7.075 | 100.0 | 100.0 |

| | Bottoms | | |
|---|---|---|---|
| | Lb. | Wt. (%) | Mol (%) |
| L.K.—methanol | 0.01 | 0.02 | 0.03 |
| H.K.—ethanol | 8.25 | 18.61 | 22.97 |
| propanol | 36.00 | 81.37 | 77.00 |
| | 44.26 | 100.00 | 100.00 |

Note: L.K. and H.K. refer to the light-key and heavy-key components respectively.

Determine the dew point of the vapors above the top plate and bubble point of the feed liquid and the bubble point of the liquid bottoms in the reboiler, assuming the pressure throughout the column to be 20 psia. or 1,031 mm. Hg.

$$\text{Dew point defined by } \Sigma x = 1.0 = \Sigma \frac{yP_T}{P} \qquad (23)$$

Trial-and-error calculation; assuming t's:

| | y Distillate | P at 73° C., mm. Hg | y (1,031) | y (1,031)/P |
|---|---|---|---|---|
| Methanol | 0.997 | 1,035 | 1,029 | .994 |
| Ethanol | 0.003 | 600 | 3 | .005 |
| | | | 1,032 | .999 = 1.0 |

Therefore, 73° C. is dew-point temperature of $V_1$, vapor from top place:

$$\text{Bubble point defined by } \Sigma y = 1.0 = \Sigma \frac{xP}{P_T} \qquad (24)$$

| | x Bottoms | P at 100° C., mm. Hg | xP |
|---|---|---|---|
| Methanol | 0.0003 | 2,700 | 0.8 |
| Ethanol | 0.2297 | 1,690 | 388.0 |
| Propanol | 0.7700 | 840 | 647.0 |
| | | | 1,035.8 |

$$\Sigma \frac{xP}{P_T} = \frac{1,035.8}{1,031} = 1.002$$

Therefore, 100° C. is bubble point of bottoms.

**BUBBLE POINT OF FEED**

| | $x_F$ | P at 91.5° C., mm. Hg | xP |
|---|---|---|---|
| Methanol | 0.22 | 2,000 | 440 |
| Ethanol | 0.18 | 1,225 | 221 |
| Propanol | 0.60 | 600 | 360 |
| | | | 1,021 |

$$\Sigma \frac{xP}{P_T} = \frac{1,021}{1,031} = 0.992$$

Therefore, feed temperature = 91.5° C. The column conditions are thus fixed and shown in Fig. 11.

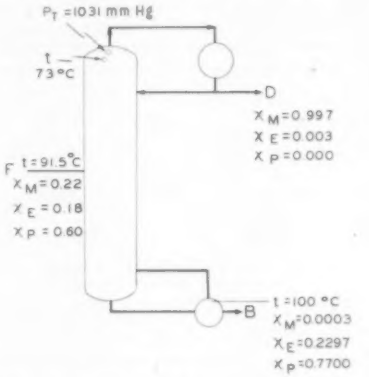



**Fig. 11—Column conditions, example calculation.**

## Minimum Stages

**"Exact" plate to plate . . .** In operating a column at total reflux there is no distillate produced from the column and no bottoms withdrawn. Therefore, no feed is continuously introduced. The operation is a 100 per cent recycle operation with no feed.

From material balance (see envelope in Fig. 12):

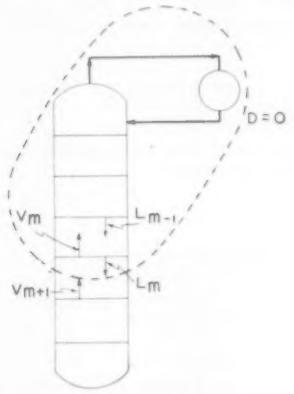



**Fig. 12—Conditions for total reflux—minimum stages.**

$$V_{m-1} = L_m \qquad (25)$$

$$y_n V_{m-1} = x_n L_m \qquad (26)$$

$$\text{Therefore, } y_{nm-1} = x_{nm} \qquad (27)$$

In the "exact plate to plate" method the procedure is as follows:

1. Knowing the temperature at Plate 1 and the vapor composition at Plate 1 calculate the composition of the liquid leaving Plate 1 from:

$$\gamma_{x1}\, x_{x1}\, P_{x1} = Y_{x1}\, P_T$$

$$x_{x1} = \frac{y_{x1}\, P_T}{\gamma_{x1}\, P_{x1}}$$

However, in this system the value of $\gamma$ for all components can be assumed to be approximately unity.

2. From Equations 25, 26, and 27 both the quantity of $V_2$ and $L_1$ are the same and the compositions are the same. Thus:

$$y_{x2} = x_{x1}, \text{ etc.}$$

3. Assume temperatures for Plate 2 until the sum of:

$$x\text{'s} = 1.0 \text{ (calculate from } \Sigma x = 1.0 = \Sigma \frac{yP}{P_{T*}})$$

4. Again from material balance:

$$y_3 = x_2; \text{ evaluate } y_3$$

5. Assume temperatures for Plate 3 until:

$$\Sigma x_3 = 1.0 = \Sigma \frac{yP}{P_T}$$

6. Continue for two or three plates and add some of the heavier than heavy key (in example add propanol) in the amount of 0.001 to 0.005 mol fraction.

7. Continue for a number of plates down the column.

8. Starting with the reboiler composition $x_b$ calculate in the same manner up the column for a number of plates.

9. Plot the compositions calculated in progressing down the column against the number of plates and on the same plot, plot the compositions progressing up the column.

10. Inspection of the plot will indicate the approximate match of the compositions at one plate.

11. Count the plates down the column to this plate and the plates up to this plate including it. Add them and subtract one stage (for the reboiler). This is the minimum plates at total reflux.

Inspection of the composition versus number of stages plots for the components may indicate that all component compositions do not match at the same plate. For exact work the above procedure is repeated changing the amounts of components added arbitrarily until the match is obtained.

**Algebraic short-cut methods . . .** The calculation methods for minimum stages developed by Underwood[5,6] and Fenske[22] are essentially the same. The equation for minimum plates is:

$$S_m = \frac{\log\ [(x_{LK}/x_{HK})_D\ (x_{HK}/x_{LK})_B]}{\log\ \alpha_{LK/HK}} \qquad (28)$$

where:

$S_m$ = minimum stages
$x_{LK}$ = mol fraction light key
$x_{HK}$ = mol fraction heavy key
D, B = subscript denoting distillate and bottoms respectively
$\alpha_{LK/HK}$ = relative volatility of the light key to the heavy key, computed by:

$$[(\alpha_{top\ t.})\ (\alpha_{bot.\ t.})]^{1/2}$$

Fenske utilizes the compositions of distillate and bottoms directly. Underwood calculates two to four plates down and up by plate-to-plate calculations and applies the equation to the liquid streams at the plates calculated.

For a total condenser and reboiler:

$$S_m - 1 = \text{minimum plates}$$

For partial condenser and reboiler:

$$S_m - 2 = \text{minimum plates}$$

**Example (continued)**

Determine the minimum plates for the system methanol-ethanol-propanol described above by the Fenske method.

**Solution:**

$\alpha_{LK/HK}$ at 73° C. = 1.73; $\alpha_{LK/HK}$ at 100° C. = 1.6

$$\alpha_{ave} = [(1.73)\ (1.6)]^{1/2} = 1.662$$

$$S_m = \frac{\log\ [(0.997/0.003)\ (0.2297/0.0003)]}{\log 1.662} = \frac{\log\ (332)\ (765)}{\log 1.662}$$

$$= 5.405/0.22 = 24.6 \text{ stages}$$

Therefore, minimum plates = 24.6 — 1 = 23.6

**Graphical methods . . .** In the case of ternary systems graphical methods may be used to evaluate the number of plates at total reflux and at finite reflux. Hunter and Nash[23] used the graphical method for liquid-liquid extraction and Bonilla [3], Benedict,[2] and others applied it to regular and azeotropic distillation processes involving ternary systems.

The principal assumption involved in this method is equimolal overflow from plate to plate and/or equimolal latent heats of vaporization.

Refer to Figs. 13 and 14.

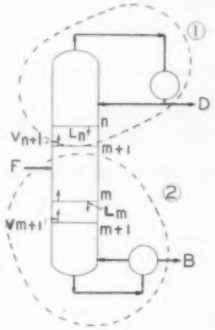



**Fig. 13—Material balances in upper and lower parts of column.**

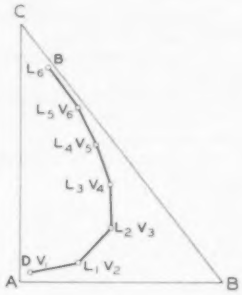



**Fig. 14—Ternary composition diagram for calculating stages at total reflux.**

In a simple ternary fractionating column it is possible to show that the difference point, V-L, at any plate above the feed is at D:

$$\text{Since } D = V - L \qquad (29)$$

$$\text{Also } x_D D = Vy - Lx \qquad (30)$$

Similarly, below the feed the difference point lies at B:

$$B = L - V \qquad (31)$$

$$x_B B = Lx - Vy \qquad (32)$$

Also, the feed composition lies on a line between D and B since:

$$F = B + D \qquad (33)$$

$$x_F F = Bx_B + Dx_D \qquad (34)$$

At total reflux from Equations 25, 26, and 27:

$$V_2 = L_1,\ V_3 = V_2, \ldots \text{ etc.}$$

$$y_2 V_2 = x_1 L_1,\ y_3 V_3 = x_2 L_2, \ldots \text{ etc.}$$

$$y_2 = x_1,\ y_3 = x_2, \ldots \text{ etc.}$$

By means of a ternary composition diagram and equilibrium data the number of stages at total reflux may be determined as follows:

1. Locate the composition points on the ternary diagram representing D and B.
2. From equilibrium data determine the composition of $L_1$ from $V_1$. This also located $V_2$. Connect (D, $V_1$) and ($L_1V_2$).
3. From equilibrium data determine the composition of $L_2$ from $V_2$ thus locating $V_3$. Connect $L_2V_3$ with $V_2L_1$.
4. Proceed in similar manner until the line of constant composition of the light component desired in the bottoms is reached.
5. The number of tie lines used in reaching this composition represents the number of minimum stages.
6. The minimum plates = minimum stages minus the reboiler.

### Minimum Reflux

**"Exact" plate to plate . . .** The exact plate-to-plate method discussed by Lewis and Matheson,[10] Edmister,[18 19] Brown and Holcomb,[7] and many others is a method of plate-to-plate calculation involving material-balance relations to establish the composition and quantity of streams between plates and equilibrium relations to relate the compositions and quantities of liquid and vapor on the plates. The assumption of equimolal overflow and equimolal latent heats of vaporization are inherent in the method. Strictly an exact plate-to-plate calculation should also use enthalpy balances around plates since the assumption of equimolal latent heats is not necessarily valid.

This method is a trial-and-error method and a very tedious one. It requires:

1. Determination of temperature and pressure above top plate.
2. Assumption of a trial L/D (minimum).
3. Calculation of L/V (assume constant throughout rectifying section).
4. Calculating by equilibrium relations the composition of $L_1$.

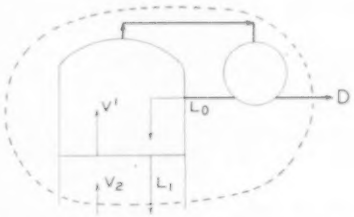



**Fig. 15—Material balance for calculation of composition and quantity of $V_2$.**

5. Calculation by material balance (and enthalpy balance if reflux is at other than bubble point temperature) the composition and quantity of $V_2$.
6. Assuming temperature of Plate 2 and calculating dew point pressure of $V_2$ until calculated pressure coincides with total pressure.
7. Calculating the composition of $L_2$ by equilibrium relations.
8. Repeating until either the composition of the liquid and vapor passing each other become equal or the composition of the bottoms is reached.

If the compositions become constant and equal, a pinch zone has been reached. If not, a lower minimum L/D must be assumed and the calculations repeated until a pinch zone is reached.

Common procedure is to start calculations with an L/D great enough to be in the operable range, determine the number of plates. Repeat with assumed L/D values in decreasing amounts and determine the plates. Plot the L/D versus number of plates. The L/D value at which the number of plates becomes infinite is the L/D (minimum).

**Algebraic short-cut methods . . .** There have been a large number of methods proposed for short-cut determinations of minimum reflux for multicomponent distillation: Brown and Martin,[6] Colburn,[13a] Mayfield and May,[42] Scheibel,[45] Bailey and Coates,[1] Scheibel and Montross,[40] Shiras, Hanson and Gibson,[21] Underwood,[52 53] Edmister,[19] and others. Only two of these methods are discussed in this article.

### Brown and Martin Method

The Brown and Martin method is based on the observation that the approximate (on the safe side) minimum reflux ratio is encountered when the ratio of compositions of the key components in the zone of constant composition or "pinch" zone are the same as the ratio of the compositions of the key components in the feed in the section of the column where the most difficult separation takes place. This is indicated by the section requiring the more plates (above or below the feed). Thus:

$$(L/D)_{minimum,\ approximate,\ occurs\ where}\ (x_{LK}/x_{HK})_{pinch\ zone} = (x_{LK}/x_{HK})_{feed}$$

**Example:** Determine the minimum reflux ratio (approximate) by Brown and Martin method.

**Solution:** Assume most difficult separation above feed plate.

Feed:

$$x_M = 0.22;\ x_E = 0.18$$

$$(x_M/x_E)_F = 0.22/0.18 = 1.222$$

**Temperature in "pinch" zone . . .** If the heavier key component, ethanol, did not appear in the distillate but did appear in the pinch zone, the temperature in the pinch zone would be that at which the $K_{ethanol} = L/V$. By using ethanol material balance in envelope in Fig. 16:

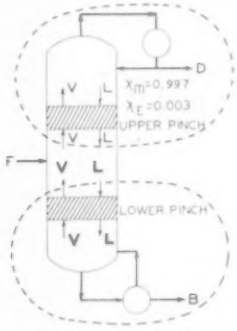



**Fig. 16—Diagram for minimum reflux calculations.**

$$Vy_E = Lx_E + Dx_{ED}$$

$$Dx_{ED} = 0$$

$$L/V = y_E/x_E = K_E$$

For this system (assumed ideal):

$$K = y_E/x_E = P_E/P_T = L/V \qquad (35)$$

Assume three temperatures, 75°, 77°, 80° C., and calculate from vapor pressures and total pressure:

$L/V = K_E$ and $K_M = P_M/P_T$

| | 75° C. | | |
|---|---|---|---|
| | K | L/V | L |
| Methanol | 1.091 | 0.625 | 0.368 |
| Ethanol | 0.625 | 0.625 | 0.368 |

| | 77° C. | | |
|---|---|---|---|
| | K | L/V | L |
| Methanol | 1.172 | 0.679 | 0.466 |
| Ethanol | 0.679 | 0.679 | 0.466 |

| | 80° C. | | |
|---|---|---|---|
| | K | L/V | L |
| Methanol | 1.31 | 0.76 | 0.698 |
| Ethanol | 0.76 | 0.76 | 0.698 |

L is evaluated from $\frac{L}{V} = K = \frac{L}{L+D}$ (36)

$$LK + KD = L \quad (37)$$

$$L(1-K) = KD \quad (38)$$

$$L = \frac{KD}{1-K} \quad (39)$$

where:
D = mols distillate/mol feed
L = mols liquid/mol feed

From component material balance:

$$yV = Dx_D + Lx;\ V = D + L;\ y = Kx$$

$$x = \frac{Dx_D}{KD + L(K-1)} \quad (40)$$

$$\Sigma x = 1.0 = \Sigma \frac{Dx_D}{KD + L(K-1)} \quad (41)$$

Example for 75° C.:

$$Dx_D = \frac{\text{mol distillate}}{\text{mol feed}}$$

| | $Dx_D$ | K | KD | L(K − 1) | x |
|---|---|---|---|---|---|
| Methanol | 0.2200 | 1.091 | 0.241 | 0.0345 | 0.800 |
| Ethanol | 0.00076 | 0.625 | 0.1380 | −0.1380 | *0.200 |

*Obtained from $1.0 - x_{methanol} = x_{ethanol}$

Note: The composition of the heavy key is always determined as the difference between 1.0 and the sum of the composition of the lighter key and lighter components.

Summarizing for the temperatures assumed:

| t | L/V | $x_m$ | $x_E$ | $x_m/x_E$ |
|---|---|---|---|---|
| 75° C. | 0.625 | 0.800 | 0.200 | 4.00 |
| 77° C. | 0.679 | 0.650 | 0.350 | 1.86 |
| 78° C. | 0.703 | 0.560 | 0.440 | 1.271 |
| 80° C. | 0.76 | 0.442 | 0.558 | 0.793 |

$(x_m/x_E)_F = 0.22/0.18 = 1.22$

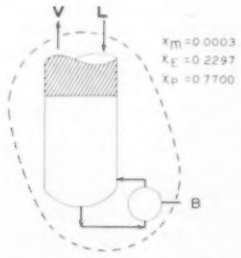



**Fig. 17—Separation in the bottom section of the column.**

Therefore, (L/V) minimum lies between 0.703 and 0.76.

From a plot of (L/V) versus ($x_M/x_E$) the appropriate minimum reflux is 0.76. Therefore, (L/V) minimum = 0.706; (L/D) minimum = 2.40. Assuming the separation to be more difficult in the bottom section (see Fig. 17) the equations analogous to the equations developed for the stripping section are:

$$x = \frac{Bx_B}{BK + L(1-K)} \quad (42)$$

$$\Sigma x = 1.0 = \Sigma \frac{Bx_B}{BK + L(1-K)} \quad (43)$$

$$L/V = K_{LK} \quad (44)$$

In this case the **L/V** would be equal to the K value for the light key component at the temperature and pressure in the pinch zone if the light key appeared in the pinch zone and did not appear in the bottoms product.

Assume three temperatures, 90°, 92°, and 94° C., and calculate the K values and **L/V** for the lower pinch zone.

| | 90° C. | | |
|---|---|---|---|
| | K | L/V | L |
| Methanol | 1.840 | 1.840 | 1.760 |
| Ethanol | 1.042 | | |
| Propanol | 0.542 | | |

| | 92° C. | | |
|---|---|---|---|
| | K | L/V | L |
| Methanol | 1.952 | 1.952 | 1.597 |
| Ethanol | 1.221 | | |
| Propanol | 0.619 | | |

| | 94° C. | | |
|---|---|---|---|
| | K | L/V | L |
| Methanol | 2.133 | 2.133 | 1.465 |
| Ethanol | 1.309 | | |
| Propanol | 0.639 | | |

**L** is evaluated from:

$$(L/V)_M = K_M = \frac{L}{L-B} \quad (45)$$

$$K_M L - K_M B = L \quad (46)$$

$$L = \frac{B}{K_M - 1} \quad (47)$$

From component material balance:

$$L = V + B \quad (48)$$

$$xL = yV + Bx_B \quad (49)$$

from which

$$x = \frac{Bx_B}{BK + L(1-K)} \quad (50)$$

$$\Sigma x = 1.0 = \Sigma \frac{Bx_B}{BK + L(1-K)} \quad (51)$$

Example for 90° C.:

| | $Bx_B$ | K | L | KB | L(1 − K) | x |
|---|---|---|---|---|---|---|
| Methanol | 0.000233 | 1.840 | 1.760 | 1.423 | −1.432 | |
| Ethanol | 0.1789 | 1.042 | | 0.812 | −0.074 | 0.242 |
| Propanol | 0.6000 | 0.542 | | 0.442 | 0.806 | 0.489 |
| | 0.779133 | | | | | 0.731 |

$x_M = 1 - 0.721 = 0.269$

$x_M/x_E = 0.269/0.242 = 1.11$

From plot $x_M/x_E$ at the three temperatures versus **L**:

(**L/V**) minimum = 1.810

For saturated liquid feed:

$$V = \mathbf{V} \tag{52}$$

$$\mathbf{L} = L + F \tag{53}$$

Since basis is 1 mol. feed:

$$\mathbf{L}/\mathbf{V} = (L + 1)/V = 1.810 \tag{54}$$

$$\mathbf{L} = 1.810\ \mathbf{V} - 1;\quad \mathbf{L}/\mathbf{V} = 0.810;\quad \mathbf{L}/\mathbf{D} = 4.25$$

Since the (L/D) minimum based on the stripping or lower section of the column is greater than that based upon the upper part of the column, it would be used as the approximate minimum reflux.

Brown and Martin make the further correction for the presence of the heavy key in the overhead. Since it is present the value for $K_{HK}$ is slightly larger than L/V. Because of this a slightly larger value of $K_{HK}$ is used in the calculations. Likewise, in the bottom or stripping section pinch zone the value of $K_{LK}$ is somewhat less than **L/V** because the light key is present in the bottoms. Therefore, a smaller value of $K_{LK}$ is used in the calculations.

These added corrections should make the (L/D) minimum calculated in both top and bottom approach closer to the same value.

**Underwood method . . .** The Underwood method involves the use of the following equations:

$$(L/D)\ \text{minimum} + 1 = \frac{(\alpha_A x_A)_D}{\alpha_A - \Theta} + \frac{(\alpha_B x_B)_D}{\alpha_B - \Theta} + \ldots + \frac{(\alpha_C x_C)_D}{\alpha_C - \Theta}$$

$$= \Sigma \frac{x_D}{(\alpha - \Theta)/\alpha} \tag{55}$$

$$\frac{(\alpha_A x_A)_F}{\alpha_A - \Theta} + \frac{(\alpha_B x_B)_F}{\alpha_B - \Theta} + \ldots + \frac{(\alpha_C x_C)_F}{\alpha_C - \Theta}$$

$$= 1 - q = \Sigma \frac{x_E}{(\alpha - \Theta)/\alpha} \tag{56}$$

**Note:** $1 - q = 0$ for bubble-point feed (i.e., saturated liquid)
$1 - q = 1$ for dew-point feed (i.e., saturated vapor)

$\Theta$ must lie between the $\alpha$ values of the keys.

$\Theta$ is found by trial and error from Equation 56 and substituted into Equation 55 to evaluate (L/D) minimum. $\alpha$'s are determined at the average tower temperature.

**Example** (continued)

Find the minimum reflux ratio by means of the Underwood method.

**Solution:**

$$\text{Mean tower temperature} = \frac{73 + 100}{2} = 86.5°\ \text{C.}$$

$$\alpha_{M\text{-}P} = \frac{P_m}{P_p} = \frac{1{,}700}{480} = 3.54$$

$$\alpha_{E\text{-}P} = \frac{P_E}{P_p} = \frac{1{,}000}{480} = 2.085$$

$$\alpha_{P\text{-}P} = \frac{P_p}{P_p} = \frac{480}{480} = 1.00$$

Trial and error solution for $\Theta$:

Assume $\Theta = 2.723$

| | $x_F$ | $\alpha$ | $x_F$ | $\alpha - \Theta$ | $x_F/(\alpha - \Theta)$ |
|---|---|---|---|---|---|
| Methanol | 0.220 | 3.54 | .778 | 0.817 | 0.952 |
| Ethanol | 0.180 | 2.085 | .375 | —0.638 | —0.558 |
| Propanol | 0.600 | 1.00 | .600 | —1.723 | —0.348 |
| | | | | | +0.006 |

Therefore, $\Theta = 2.723$

| | $x_D$ | $\alpha$ | $x_D$ | $\alpha - \Theta$ | $x_D/(\alpha - \Theta)$ |
|---|---|---|---|---|---|
| Methanol | 0.997 | 3.54 | 3.530 | 0.817 | 4.32 |
| Ethanol | 0.003 | 2.085 | 0.0063 | —0.638 | —0.01 |
| Propanol | 0.000 | 1.00 | 0.000 | —1.723 | 0.00 |
| | | | | | 4.30 |

$$(L/D)\ \text{minimum} + 1 = 4.30$$

$$(L/D)\ \text{minimum} = 3.30$$

$$(L/V)\ \text{minimum} = 3.3/4.3 = 0.768$$

Comparing the results of the two methods:

| | Brown | Underwood |
|---|---|---|
| (L/V) minimum | 0.810 | 0.768 |
| (L/D) minimum | 4.25 | 3.30 |

These do not agree closely because:

1. The temperature at which the K value for the Brown method was selected is somewhat higher than the actual temperature in the pinch zone. This resulted from the assumption that no methanol was present in the bottoms.
2. The value of $x_M$ is extremely sensitive to temperature.
3. The average $\alpha$ of the Underwood method is approximate.

Normally for design calculations the maximum-minimum reflux calculated would be considered the limiting one.

### Theoretical Stages at Operable Reflux

The three types of methods discussed under total reflux are applicable to ternary systems in calculating the theoretical stages at operable reflux. Only the exact plate-to-plate and short-cut algebraic methods can be used in the case of a system with more than three components.

**Exact plate-to-plate method . . .** The following steps are customary in the exact method:

1. Select an operating reflux ratio; e.g., 1.3 (L/D) minimum.
2. Calculate quantities of L, V, **L** and **V** based on 1 mol of feed and the separation previously decided upon.
3. Start with the vapor $V_1$ at the top plate and compute the composition of $L_1$ assuming a temperature of the plate so that $\Sigma x = 1.0$.
4. From material balance calculate the quantity and composition of $V_2$.
5. After three or four plates add a small quantity; e.g., 0.0005 mols of the next heavier than heavy key component.
6. Continue as above. (Note: If more than one component heavier than the heavy key is present in the feed, add each in small quantities after three or four plate-to-plate calculations until all components present in the feed are in the liquid and vapor streams.)
7. Starting with the bottom plate calculate compositions of equilibrium streams and quantities of streams passing between plates as above.
8. Plot the compositions down and up until a plate is reached where the compositions going down the column and up the column are essentially the same.
9. If the compositions of the added components do not agree, go back to their addition point and change the quantity and repeat.
10. Do this until all compositions agree at the same

plate. Note: In a system where nonideality exists, the L/V will not be constant. Under this condition both enthalpy balances and material balances are used to evaluate stream quantities.

**Algebraic short-cut methods . . .** There have been several short-cut methods proposed for the evaluation of the actual number of theoretical plates for a definite operating reflux ratio in terms of the limiting conditions of minimum plates at total reflux and minimum reflux at infinite plates. Brown and Martin[4] and Gilliland[25] have developed charts correlating the limiting conditions with finite plates at operating reflux. The Brown-Martin chart is represented in Fig. 18.

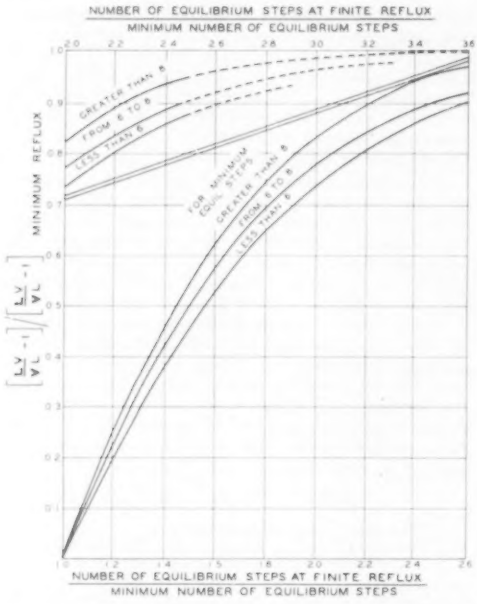

NUMBER OF EQUILIBRIUM STEPS AT FINITE REFLUX
MINIMUM NUMBER OF EQUILIBRIUM STEPS
MINIMUM REFLUX
GREATER THAN 5
FROM 5 TO 5
LESS THAN 5
FOR MINIMUM EQUIL. STEPS
GREATER THAN 5
FROM 5 TO 5
LESS THAN 5
NUMBER OF EQUILIBRIUM STEPS AT FINITE REFLUX
MINIMUM NUMBER OF EQUILIBRIUM STEPS

**Fig. 18—Brown and Martin correlation of operating reflux and number of theoretical stages with minimum stages and minimum reflux.**

**Example** (continued):

Determine the number of theoretical plates for an operating reflux ratio of 1.3 $(L/D)_{minimum}$ by the Brown-Martin method.

**Solution:**

$$(L/D) = (1.3)\,(L/D)_{minimum} = (1.3)\,(4.25) = 5.52$$

(Brown)

$$\mathbf{L/V} = 0.846;\ \mathbf{L/V} = 1.541$$

$$(L/D) = (1.3)\,(L/D)_{minimum} = (1.3)\,(3.3) = 4.3$$

(Underwood)

$$L/V = 0.812;\ \mathbf{L/V} = 1.667$$

$$\text{Minimum plates} = 23.6$$

$$\frac{(\mathbf{L/V}\,V/L - 1)}{(\mathbf{L/V}\,V/L - 1)_{minimum}} = \frac{(1.541)\,(1.180) - 1}{(1.810)\,(1.237) - 1}$$

$$= 0.82/1.237 = 0.664$$

$$N/N_{minimum} = 1.67 \text{ (Fig. 18)}$$

$$N = (1.67)\ (23.6) = 39.4 \text{ or } 40 \text{ plates}$$

$$\frac{(\mathbf{L/V}\,V/L - 1)}{(\mathbf{L/V}\,V/L - 1)_{minimum}} = \frac{(1.667)\,(1.23) - 1}{(1.82)\,(1.303) - 1}$$

$$= 1.05/1.375 = 0.764$$

$$N/N_{minimum} = 1.83 \text{ (Fig. 18)}$$

$$N = (1.83)\ (23.6) = 43 \text{ plates}$$

**Graphical method . . .** The graphical method of Bonilla[3] and Kirschbaum[35] for ternary systems can be used for the evaluation of number of plates at an operable reflux as well as for determination of minimum plates at total reflux. The use of this method requires the assumption of constant molal latent heat of vaporization and constant L/V in the rectifying section and constant **L/V** in the stripping section. If the variation of latent heat with temperature and partial molal enthalpy data are available, it is possible to calculate the L/V for each plate and use the graphical method without the simplifying assumptions.

The method applied to ternary fractionation is outlined as follows (see Fig. 19):

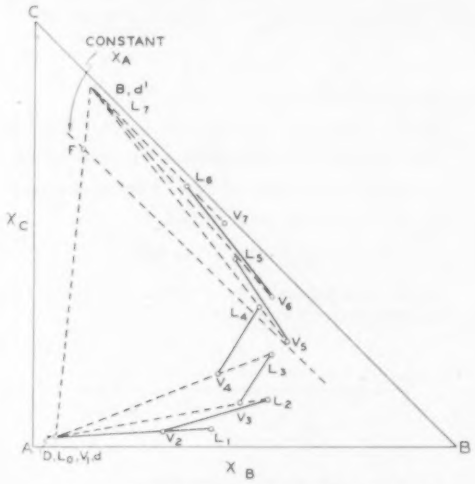



**Fig. 19—Graphical determination of equilibrium steps.**

1. For the reflux ratio selected as the operating reflux ratio, L/D, determine the internal L/V and **L/V**.
2. Plot the composition of the feed, distillate and bottoms on the ternary diagram.
3. Determine the composition of $L_1$ from equilibrium data and plot on diagram.
4. From material balance $V_2 - L_1 = D$; therefore (since L/V is assumed constant) $V_2$ represents the addition point on a line between $L_1$ and D and is located at a point on the line by:

$$\overline{DV_2}/\overline{DL_1} = L_1/V_2$$

(Note: Remember D is the difference point for the rectifying section.)

5. Locate $L_2$ from equilibrium data.
6. Connect $L_2$ and D with a straight line.
7. Locate $V_3$ as above.
8. Continue until the equilibrium tie line connecting the vapor and liquid compositions (if the feed is a saturated liquid) at some plate in the column crosses the constant composition line through the feed point with respect to the light key. If the feed is a saturated vapor,

the steps are continued until the vapor composition crosses the line.

9. When the stepwise procedure indicates the feed plate has been reached, the bottom difference point is then used. This difference point is at B, since by material balance in the stripping section: $\mathbf{L} - \mathbf{V} = \mathbf{B}$.

10. Draw a line between B and the L located from the last operation and extend the line beyond L (now $\mathbf{L}$). $\mathbf{V}$ is located by the lever-arm principle that $\mathbf{L}$ is the addition point for B and $\mathbf{V}$ and $\mathbf{V}$ is located at a distance $(\mathbf{L}/\mathbf{V})$ $(\mathbf{BL})$ from B.

11. Locate the composition of the liquid on the plate below by means of equilibrium data and extend line through it from B.

12. Locate the vapor composition as in (10).

13. Continue until the $\mathbf{L}$ located from equilibrium data coincides with B.

**Example** (continued):

For the system methanol-ethanol-propanol the Underwood minimum reflux, (L/D) minimum = 3.30 and (L/V) minimum = 0.768. For a saturated liquid feed:

$$V = V; L + F = L; \text{ and } L = V + B.$$

Assume 1.3 (L/D) minimum = (L/D) operating.

Since V = L + D and (L/D) operating = (1.3) (3.3) = 4.30.

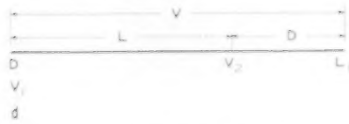
For 1 mol feed, L = (4.30) (0.2203) = 0.945 mols/mol feed.

V = V = L + D = 0.945 + 0.2203 = 1.1653 mols/mol feed.

L = L + F = 1.1653 + 1.0 = 2.1653.

$$L/V = 2.1653/1.1653 = 1.860$$

Locate D on diagram at $x_W = 0.997$; $x_E = 0.003$. This is the difference point as well as $V_1$.



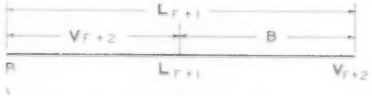

Locate $L_1$ from equilibrium relations.

$V_2$ is located by measuring the distance $\overline{dL_1}$ and multiplying it by L/V, thus:

$$\overline{dV_2} = (\overline{dL_1})\ L/V = 0.768\ (\overline{dL_1})$$

Locate $L_2$ composition from equilibrium relations and repeat.

After $L_{F+1}$ is located by the construction, connect $L_{F+1}$ with B and extend the line beyond $L_{F+1}$. Locate $V_{F+2}$ by means of the lever-arm principle.




Multiply the distance $\overline{dL_{F+1}}$ by L/V to locate $V_{F+2}$, thus:

$$\overline{L} = \overline{dL_{F+1}}\ (L/V) = \overline{dL_{F+1}}\ (1.860)$$

Locate $L_{F+2}$ by means of equilibrium relations and repeat until at some plate $\mathbf{L} = \mathbf{B}$ (in the construction $\mathbf{L}$ terminates at point B).

### Actual Number of Stages—Efficiency

The actual number of stages or plates is determined by:

$$N_A = N_T/E \qquad (57)$$

where:
$N_A$ = actual number of stages or plates
$N_T$ = number of theoretical equilibrium plates or stages
E = efficiency fraction

Factors affecting efficiency are:

1. Contact of vapor and liquid at a given stage.
2. Carryover—vapor in liquid, liquid in vapor.
3. Viscosity, density and surface tension.

### Methods of Evaluating Efficiency

Efficiency of a fractionating column as indicated above depends not only upon the design of the plates or contact stages but upon the characteristics of the vapor-liquid system and the operating conditions. Efficiency of a column is defined as the number of theoretical equilibrium stages necessary to make a given separation divided by the actual number of stages required. Prediction of expected efficiencies in design of the column is in the nature of intelligent guessing rather than calculation.

A number of methods have been presented for evaluating plate efficiency or efficiency of one stage such as Murphree[41] and Geddes[24] have proposed. The column efficiency can be considered the same as the plate efficiency and thus the actual number of stages can be predicted. This, of course, assumes all plates or equilibrium stages in the column to have the same efficiency.

Others have attempted to develop empirical relations for determining average plate efficiency which can be considered the column efficiency. Drickamer and Bradford[17] and O'Connell[42] presented correlations of this type. The Drickamer and Bradford plot correlates average plate efficiency and average molal viscosity of the feed material at the average temperature in the column. The equation for the correlation is:

$$E = [0.17 - 0.616 \log_{10} \Sigma\ (\mu_m)_F]\ 100 \qquad (58)$$

where:
E = average plate efficiency, per cent
$\Sigma\ (\mu_m)_F$ = average molal viscosity of the feed material at the arithmetic average tower temperature (centipoises)

$$\Sigma\ (\mu_m)_F = (x_A\mu_A)_F + (x_B\mu_B)_F + \ldots + (x_n\mu_n)_F \qquad (59)$$

The O'Connell correlation incorporates the variable of key component relative volatility in addition to the average molal viscosity.

Commercial column efficiencies vary from low values of 25 per cent to values in excess of 100 per cent. While this latter appears impossible, efficiencies over 100 per cent can be obtained in some instances because of added mass transfer in the space between plates from the liquid droplets to the vapor phase. This in effect adds differential fractional distillation to the stage fractionation and gives more total mass transfer than could be obtained from the plates alone.

### Fractionating Column Design—General Considerations

A well-designed fractionating column should:

1. Produce the desired quality of product at or near the minimum operating and investment cost per unit of product.

2. Operate satisfactorily over a range of liquid loads without excessive pressure drop and remain within the region of stable operation.

3. Operate satisfactorily over a range of vapor loads without excessive pressure drop and without efficiency-reducing entrainment.

The first of these considerations depends primarily

upon the number of stages (or height of packing) provided for the separation and the reboiler and condenser capacity provided for handling a range of reflux ratios. The other two considerations are primarily capacity factors which are provided for by use of adequate safety design factors.

### Types of Fractionating Columns

Fractionating columns can be classified into equilibrium stage columns wherein commonly the following types of contact stage are used: (a) bubble-cap plates, (b) perforated or seive plate, and (c) Koch Kaskade plate; and differential contact or packed columns wherein a number of packings may be utilized to contact the vapor and liquid streams.

### Equilibrium Stage Fractionating Columns

**Bubble-cap columns**[5 20 60] . . . In a bubble-cap column the contact stage is a plate on which are mounted a number of vapor-liquid contact devices called bubble caps (see Fig. 20). These caps are so designed to contact the vapor

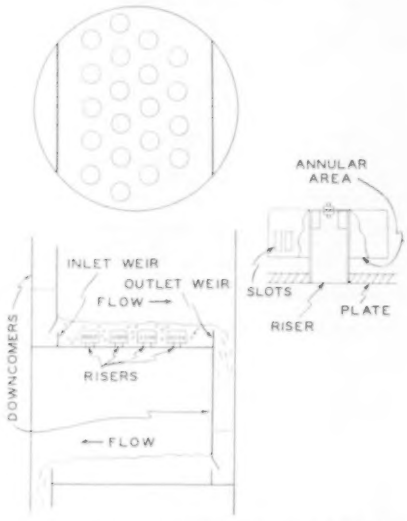



Fig. 20—Bubble-cap plate. Cap assembly is at right.

and liquid by virtue of breaking up the vapor stream into small streams which bubble through the liquid on the plate surrounding the caps. The vapor rises from the plate below through the **risers** or **uptakes,** flows into the **annular space** between the riser and the cap inner walls, and out the **slots** into the liquid.

The cap shape can be round, oval, hexagonal, square, or rectangular. The height-width or height-diameter ratio can vary from two in the case of small caps to one-third in the case of large caps. Round caps are available in sizes from 1 to 6 in. in diameter. Special sizes can be obtained.

The slots in the caps can be rectangular, square, diamond-shaped, triangular, round, and oval. They may extend to the bottom of the cap edge leaving open bottom slots or may be located some distance up the side of the cap. Normally it is desirable to select caps with total slot areas equal to the riser area and equal to the annular area in the cap assembly.

The liquid head is maintained on the plate by means of **weirs, inlet,** or **distributing,** and **outlet.** These weirs are of sufficient height to maintain liquid depths to cover the top of the cap slots.

The liquid is transferred from one plate to another by means of **downcomers,** or **downtakes.** These may be circular, oval, segmental, or rectangular.

**Koch Kaskade plate**[23 40 41 57] . . . Koch Engineering Co. developed a novel type of contact device (see Fig. 21) for fractionation and absorption equipment. This essentially consists of a series of small liquid trays attached to perforated vertical, curved baffles against which the liquid entrained by the vapor passing through the liquid trays impinges and falls to the next liquid tray. Low pressure drop, high capacity, and high efficiency are claimed for this device.

**Perforated plates**[10 11 42 50] . . . Perforated plates have been used as contact stages for a number of years in fractionation, absorption, and extraction. The plate, shown with weirs and downcomers in Fig. 22, has not been considered to be too efficient in the past but recent unpublished studies have indicated that it can be efficient when designed and operated properly. Another limitation to their use has been a narrow range of capacity for efficient operation. This also, based on recent data, appears to be a correctable fault.

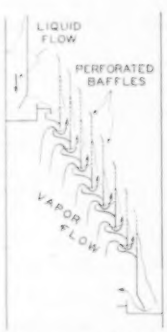



Fig. 21—Koch Kaskade plate.

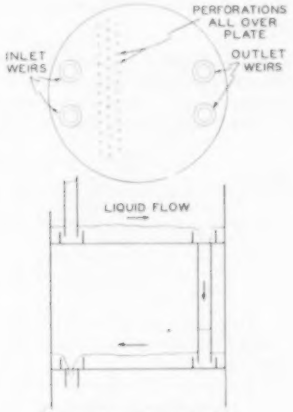



Fig. 22—Perforated plate.

**Packed columns**[6 13 36 37 46 50 53] . . . Packed distillation columns consist of cylindrical towers, sections of which are filled with various packing materials so designed to give a large interfacial contact area between vapor and liquid phases. Each section has a packing support and vapor and liquid distributing trays to reduce channeling. These columns are differential fractionating devices in that the compositions of both liquid and vapor are changing throughout the tower and are different at any point in the tower from those at any other point.

The packings available for packed distillation columns are many and varied. A few of these commonly used are berl saddles, Raschig rings, helices, springs, Fenske packing, Stedman packing, Schofield packing, Cannon packing, and others.

A complete discussion of packed columns with references is available in Leva's book.[37]

### Design Procedure—Bubble-Cap Columns

The normal procedure in designing bubble-cap columns is shown in the following steps:

1. Determination of actual number of plates.
2. Column diameter.
3. Selection and arrangement of caps.
4. Plate design.
5. Plate spacing and column height.
6. Manholes or handholes.
7. Feed manifold location.
8. Liquid and vapor transfer lines.
9. Condenser.
10. Reboiler.
11. Accumulator.
12. Controls.

The determination of the actual number of stages has been discussed above.

**Column diameter**[9 14 15 24 52] . . . The diameter of the fractionating column is commonly determined by empirical relations based on a limiting vapor velocity in the open or free cross-sectional area of the column (sometimes called superficial area). The limiting vapor velocity is generally considered the maximum vapor velocity which can be attained in the open column without loss in efficiency caused by entrainment of the liquid droplets in the vapor stream and the carrying of these droplets to the plate above.

Two methods used for evaluation of column diameter, those of Brown, and Kirkbride, are discussed in the following:

**Column diameter—Brown method . . .** Brown and coworkers correlated vapor velocity, plate spacing, density of vapor and liquid, surface tension, and efficiency.

The relation which they derived is:

$$W = C\,[\rho_V(\rho_L - \rho_V)]^{1/2} \qquad (60)$$

where:
- $W$ = pounds of vapor per hour per square foot of free cross-sectional area of column
- $C$ = factor from chart (Fig. 23) depending upon plate spacing and surface tension of liquid
- $\rho_V, \rho_L$ = density of vapor and liquid respectively, pounds per cubic foot, at the temperature and pressure in the column at the point of greatest vapor load

This relation requires assumption of plate spacing. Subsequent calculations will check the adequacy of the spacing assumed.

The steps in the use of this method are as follows:

1. Compute the maximum vapor load in the column (usually at the top plate, but can be at the feed plate or reboiler in some instances).

2. Compute or obtain the surface tension of the liquid at the temperature and composition at the point of maximum vapor load in the column.

3. Compute the densities of the vapor and liquid at that point (at that temperature and pressure).

4. Assume plate spacing.

5. Read C from Fig. 23.

6. Compute W from Equation 60.

7. Determine area of column by Equation 61:

$$A = Q/W \qquad (61)$$

where:
- $A$ = cross-sectional area of column, sq. ft.
- $Q$ = maximum vapor load, pounds per hour
- $W$ = allowable vapor load, pounds per hour per sq. ft.

8. Calculate diameter D from Equation 62:

$$D = 4A/\pi \qquad (62)$$

**Example** (conitnued):

Determine column diameter by Brown method to handle 6,000 lb. of distillate per hour (methanol, ethanol, propanol system). Use:

$$(L/D)_{operating} = 4.29$$

$$t_{top\ plate} = 73^\circ\ C.$$

$$x_M = 0.997$$

$$x_E = 0.003$$

Solution:

$L/D = 4.29$; $D = 6{,}000$; $L = (6{,}000)(4.29) = 25{,}740$ lb./hr.

$V_1 = L + D$; $V_1 = 25{,}740 + 6{,}000 = 31{,}740$ lb./hr.

Assume plate spacing 24 in.

Surface tension estimated at 15 dynes/cm.

C from Fig. 23 = 600

$$\rho_V = \left[\frac{(0.997)(32) + (0.003)(46)}{359}\right][(273/346)\ (1{,}031/760)]$$

$$= 0.00927 \text{ lb./cu. ft.}$$

$$\rho_L = 48.1 \text{ lb./cu. ft.}$$

$$W = 600\ [0.00927\ (48.1 - 0.00927)]^{1/2} = 600\ (0.445)^{1/2} = 400$$

$$A = Q/W = 31{,}740/400 = 79.5 \text{ sq. ft.}$$

$$D = (4/\pi)\ (79.5) = (101)^{1/2} = 10.03 \text{ ft.}$$

Use 10-ft. diameter

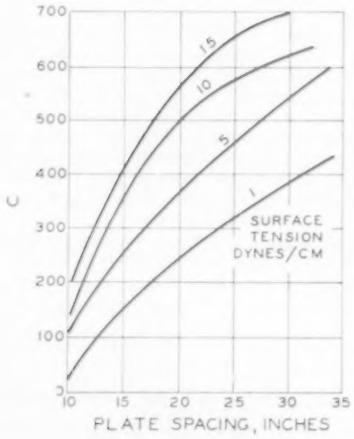



Fig. 23—C-factor chart.

**Column diameter—Kirkbride method . . .** The empirical relation for maximum vapor velocity offered by Kirkbride is:

$$V = 3.5\ (T/MP)^{0.5} \qquad (63)$$

where:
- $V$ = maximum allowable vapor velocity, ft./sec. based on free cross-sectional area
- $T$ = temperature, °F.
- $P$ = pressure, psia.
- $M$ = molecular weight of vapor

**Procedure:**

1. Determine maximum vapor load in cubic feet per second at point of maximum vapor load.

2. Determine V in Equation 63 at temperature and pressure at point of maximum vapor load.

3. Calculate area by dividing maximum vapor load by maximum allowable velocity.

4. Calculate diameter.

Note: The average commercial fractionating column vapor velocities normally fall within the following ranges:

| Column pressure— | Vapor velocity |
|---|---|
| Atmospheric pressure | 2- 3 ft./sec. |
| Pressure, 100-200 psia | 1- 2 ft./sec. |
| Vacuum | 5-12 ft./sec. |

### Plate Design[5]

After the column diameter has been computed, the plate design and layout is made. The principal considerations are:

1. Selection and arrangement of caps.
2. Selection of type of weirs and downcomers.
3. Selection of weir height.
4. Determination of vapor disengaging distance from last row of caps to overflow weir.

**Selection and arrangement of caps . . .** The gas type is chosen from the standpoint of the service in which it is to be used. For vacuum work where low-pressure drop per plate must be maintained, the low-form, low-slot type is used. Where pressure drop is not important other types may be used. In general, the size and shape of cap is selected so that the total slot areas of all caps on the plate represents the maximum available for conventional arrangement. The ratio of total slot area to free cross-sectional area of the column rarely exceeds 0.10 to 0.12 for the best arrangement of caps on the plate. The riser size should be so selected that the riser area equals the annular area and also equals the slot area of the cap.

It is customary to arrange caps in equilateral triangular spacing on the plate as shown in Fig. 24.

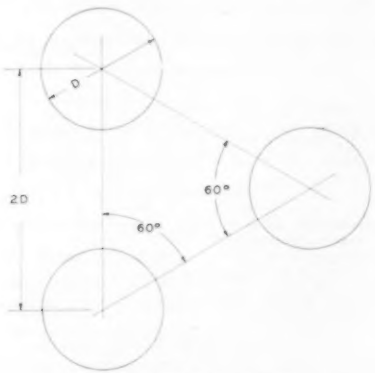



**Fig. 24—Cap-spacing diagram.**

For small sizes of caps, 1 to 3 in. in diameter, the distance between centers is normally equal to two cap diameters. For the larger sizes the distance between the walls of adjacent caps ranges from 2 to 4 in. The practice of crowding caps together on a plate is to be avoided because it increases resistance of liquid flow across the plate, increases buildup, and tends toward unstable plate operation.

**Plate arrangement . . .** In addition to the cap arrangement, it is necessary to select the flow arrangement across the plate to give the maximum liquid-vapor contact without excessive interference of the flow of the liquid across the plate. Fig. 25 illustrates a number of plate arrangements with the range of column diameters for which each is used.

**Weirs and downcomers . . .** As indicated in Fig. 25, a number of weir and downcomer types may be used. Segmental weirs tend to give even crossflow as do rectangular weirs. Circular weirs are easier to manufacture and install and are used in radial and reverse flow plates.

The downcomers may be segmental, circular, or rectangular. The overflow weirs may be the upper end of the downcomers or the weir-downcomer arrangement may be segmental-circular or rectangular-circular.

The weir height is selected to maintain a sufficient head of liquid on the plate to adequately submerge the top of the slots. Again, where low-pressure drops are necessary, the weir height is selected to give shallow submergence. Where pressure drop is not important, greater depths may be maintained by greater weir height. Minimum slot submergence; that is, the distance from the top of the slot to the top of the weir, may normally range from ¼ to 2½ in.

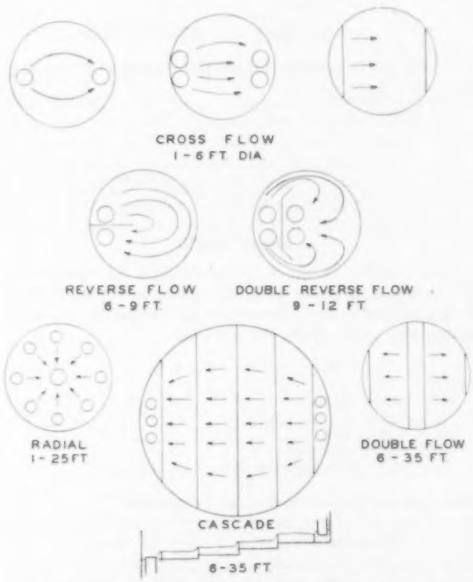



**Fig. 25—Plate arrangements for distillation columns.**

**Vapor disengaging area . . .** The location of the weir in relation to the last row of caps is important. If the last row is too close to the overflow weir, entrained vapor in the liquid will be carried into the downcomer and on to the plate below. Therefore, it is necessary to allow enough distance to enable the vapor to disengage from the liquid.

This distance is calculated as follows from experimental vapor disengaging times:

1. Calculate the height of liquid above the plate at the overflow weir, $h_w + h_{ow}$ (weir height plus the height of liquid flowing above the weir).

2. Using the weir length, $W_{average}$, calculate the cross-sectional area of flow:

$$A = (h_w + h_{ow})\, W_{average}$$

3. Calculate the liquid flow rate in cubic feet per second, Q.

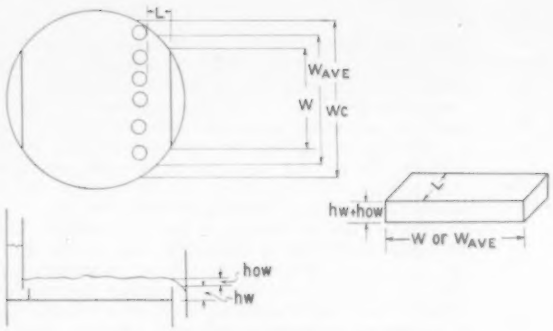



Fig. 26—Vapor disengaging space in column.

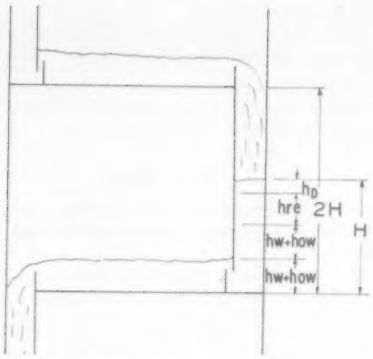



Fig. 27—Liquid backup in downcomer.

4. Calculate disengaging time for plate design from:

$$\Theta = \frac{\Theta_{laboratory}}{(h_w + h_{ow})} = \frac{\text{sec./ft.}}{\text{ft.}} = \text{sec.}$$

5. Calculate volume of flow per allowable disengaging time:

$$V = Q/\Theta = \text{cu. ft.}$$

6. Calculate L from:

$$L = \frac{V}{(h_w + h_{ow})\,W_{average}} = \frac{\text{cu. ft.}}{\text{sq. ft.}} = \text{ft.}$$

### Column Height

The column height is determined by the number of actual stages or plates plus the liquid accumulator depth at the bottom of the column plus the height of the liquid disengaging space above the top plate.

$$H_c = (N)\,(H) + H_B + H_T \qquad (64)$$

where:
- $H_c$ = column height
- N = number of actual stages
- H = plate spacing
- $H_B$ = bottom accumulator
- $H_T$ = height above top plate

**Plate spacing—liquid backup in downcomer**[6, 14, 24] . . . Refer to Fig. 27. When the difference in pressure between any two plates becomes great enough to force the liquid back up in the downcomer to the plate above, the column becomes inoperable and is said to have flooded. The column becomes completely filled with liquid.

Safe design requires calculation of the height of liquid in the downcomer under normal operating conditions and then specifying the distance between plates to be at least twice the calculated height.

The liquid height in the downcomer above the height of liquid on the plate measures the pressure drop between the plates in inches of fluid on the plate at the temperature and pressure conditions in the same manner as a manometer.

The factors causing pressure drop between plates are:

1. Liquid head represented by the distance from the top of the cap slots to the surface of the liquid.
2. Pressure drop caused by the vapor passage through the cap assembly (orifice losses).
3. Pressure drop caused by liquid flow through the restricted areas in the liquid-flow system (downcomer and seal pot).
4. Resistance of liquid flow across the plate.

There are many methods of calculating the pressure drop and the liquid height in the downcomer. Kirkbride's and Cicalese's, and others, methods will be discussed.

**Kirkbride method**[24] . . . Refer to Fig. 27. Kirkbride arbitrarily assumed the height of backup, H, measured from the plate surface to be represented by three terms:

$$H = 2\,(h_w + h_{ow}) + h_{rv} + h_D \qquad (65)$$

where:
- H = inches of liquid backup in downcomer measured from plate surface
- $h_w$ = weir height, inches
- $h_{ow}$ = height of liquid flowing over weir, measured from top of weir, inches
- $h_{rv}$ = head loss caused by vapor fraction in cap assembly, inches
- $h_D$ = head loss caused by liquid friction in downcomer, inches

The values of $h_{rv}$ and $h_D$ are calculated as follows:

$$h_{rv} = V_s^2\,(\rho_v/\rho_L) \qquad (66)$$

where:
- $h_{rv}$ = inches liquid
- $V_s$ = velocity through slots, riser, or annular space, whichever is greatest, ft./sec.
- $\rho_L, \rho_V$ = densities, lb./cu. ft. of liquid and vapor at t and $P_c$

$$h_D = 0.6\,V_d^2 \qquad (67)$$

where:
- $h_D$ = head loss, inches of liquid, in most restricted liquid flow area in downcomer
- $V_d$ = velocity in ft./sec. of liquid flowing through the most restricted cross-section of flow

$h_{ow}$ is calculated by trial and error using Equation 68:

$$h_{ow} = 30K\,(L'/W)^{0.667} \qquad (68)$$

where:
- $h_{ow}$ = liquid height flowing over weir, inches
- K = proportionality factor correcting for restricting tower wall (K = 1.0 for circular weirs)
- L′ = liquid load in cu. ft./sec. flowing on plate
- W = weir length in inches

Calculation of $h_{ow}$ by trial and error. Refer to Fig. 28:

1. Know or fix W (in segmental weirs W = 0.8 D) and calculate W/D.
2. Assume $h_{ow}$.
3. From chart read U/D.
4. Calculate U′ = U — $h_{ow}$ and U′/D.
5. From chart read W′/D.
6. Calculate W/W′.
7. From chart read value of K.
8. Calculate $h_{ow}$ from Equation 68.

If $h_{ow}$ calculated does not equal $h_{ow}$ assumed, assume a new value of $h_{ow}$ and repeat until values agree within

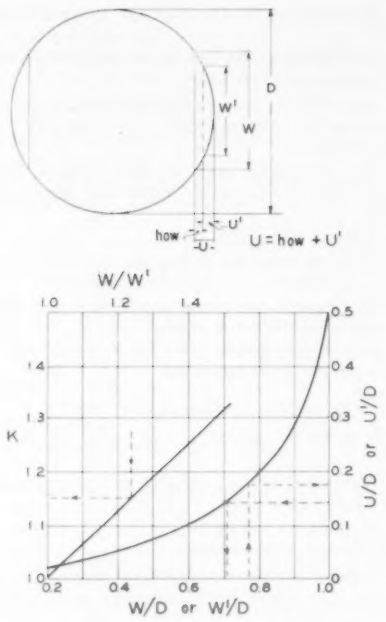



**Fig. 28—Evaluation of $h_{ow}$ term.**

2 per cent. When agreement is reached, calculate plate spacing by Equation 69:

$$\text{Plate spacing} = 2\,(H) \tag{69}$$

**Cicalese method**[14 15] . . . In the Cicalese method the liquid backup is calculated by means of Equation 70:

$$H = 2\,(h_w + h_{ow}) + h_g + h_{ds} + h_{rc} \tag{70}$$

where:
- H = liquid backup in inches measured from the surface of the plate
- $h_w$ = weir height, inches
- $h_{ow}$ = height of liquid over the weir, inches

$$h_g = 0.00093\,\frac{V_p^2\,L}{A/P} \tag{71}$$

where:
- $h_g$ = head loss caused by liquid gradient across plate, inches
- $V_p$ = average linear velocity of liquid flowing across plate, ft./sec.
- A = average cross-sectional area of liquid stream
- L = length of liquid flow path, in feet
- P = average wetted perimeter, in feet

$$h_{ds} = 0.8\ V_s^2 \tag{72}$$

where:
- $h_{ds}$ = head loss by contraction and expansion of liquid flow path in downcomer
- $V_s$ = liquid velocity through minimum cross-section of liquid path, ft./sec.

$$h_{rc} = 1.43\ V_r^2\ (\rho_V/\rho_L) \tag{73}$$

where:
- $h_{rc}$ = head loss caused by expansion and contraction of vapors in cap assembly, inches
- $V_r$ = velocity of vapors through minimum cross-section of flow path, ft./sec.
- $\rho_V, \rho_L$ = densities of vapor and liquid, lb./cu.. ft.

The corrected head of liquid in the downcomer (backup) in inches of fluid flowing is calculated by Equation 74:

$$H\ (\text{corrected}) = H[\rho_L/(\rho_L - \rho_V)] \tag{74}$$

This correction is necessary only in high-pressure columns where the density of the vapor becomes appreciable.

**Pressure drop**[21 34 47] . . . Pressure drop can be calculated in the same manner as the liquid backup in the downcomer. However, for pressure drop the reference plane is not the plate surface but the surface of the liquid on the lower plate. The pressure-drop equation then becomes:

$$\Delta P = (h_w + h_{ow} + h_p/2 - x) + h_{rc} + h_g + h_{ds} \tag{75}$$

where:
- $\Delta P$ = pressure drop across a plate, inches of fluid flowing
- $h_w$ = height of weir, inches
- $h_{ow}$ = height of fluid over the weir
- $h_p$ = height of liquid at inlet weir above the weir minus height of liquid at outlet weir over the weir; i.e., ($h_{ow}$ in — $h_{ow}$ out), inches
- x = distance from surface of plate to top of cap slot, inches
- $h_{rc}$, $h_g$, and $h_{ds}$ defined as above.

The corrected pressure drop in mm. Hg can be computed from Equation 76:

$$\Delta P_{Hg} = \Delta P\ (\text{fluid})\ (\rho_F/\rho_{Hg}) = \Delta P\ (\text{fluid})\ \frac{\rho_F}{(62.4)\ (13.6)} \tag{76}$$

In terms of pounds per square inch:

$$\Delta P\ (\text{psi.}) = \Delta P\ (\text{fluid})\ (\rho_F/62.4)\ (0.03611) \tag{77}$$

**Plate stability**[16 20 26 31] . . . In large-diameter columns where long flow paths are encountered by the liquid flowing across the plate, the resistance of the caps to flow causes the liquid to build up at the inlet weir. This causes an excessive hydraulic gradient across the plate. The liquid depth is greater on the plate at the inlet row of caps than at the outlet row of caps (see Fig. 29). The hydraulic

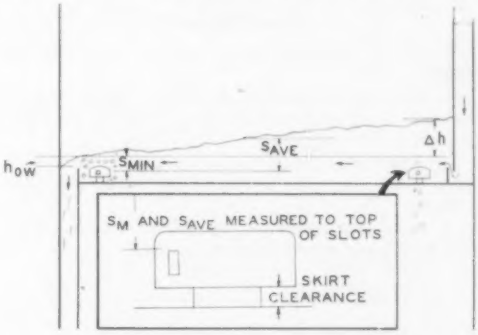



**Fig. 29—Liquid gradient on distillation plate.**

pressure at the inlet row becomes great enough to stop the flow of vapor through these caps and the caps near the outlet weir take the entire vapor flow. The liquid runs through the inlet cap risers and "weeps" or "dumps" to the plate below. At the same time the vapor through the caps near the outlet weir "cones" or "blows out" the liquid and the pressure between plates is momentarily equalized. This procedure is repeated again and again and the column and plates are said to be in "unstable" operation.

The point of **"bare minimum stability"** is defined as the point at which the vapor just stops bubbling through the inlet row of caps.

Good et al.[26] studied this problem experimentally and found that buildup of liquid or increased hydraulic gradient is increased by:

1. Increased vapor velocities.
2. Increased liquid flow rate.

3. Increased number of rows of caps normal to flow of fluid.

4. Increased cap concentration; i.e., number of caps per square foot of plate surface.

5. Decreasing skirt clearance.

6. Decreasing liquid level.

Figs. 30 and 31 resulted from the experimental study and are given as **limiting** curves. It is important to note that these are crossplotted from data on definite cap size, spacing, and plate arrangement and for the system air-water. It is to be further noted that Fig. 31 is for the limiting condition of bare minimum plate stability only.

The equations developed by the investigators to use with these figures are as follows:

$$S_{av} = S_m + \Delta h/2 \quad (78)$$

$$\Delta h = \Delta h_l \text{ (GPH per ft./1,000) (No. of rows/12)} \quad (79)$$

$$\Delta h_w = \Delta h_F (\rho_F/\rho_w) \quad (80)$$

where:

$S_{av}$ = average seal, inches of water; i.e., the average liquid depth above the cap slots

$S_m$ = minimum submergence, inches of water; i.e., the depth of the liquid above the slots of the caps at the surface of the liquid at the overflow weir

$\Delta h$ = inches of water, depth of fluid at inlet weir above the surface of the fluid at outlet weir

$\Delta h_l$ = inches of water buildup, based on 1,000 gal. per ft. of plate width normal to flow and 12 rows of caps. Read from chart (Fig. 30)

GPH per ft. = gallons per hour per foot of plate width. (In circular columns use arithmetic average width between longest and shortest rows of caps)

No. of rows = number of rows of caps normal to flow of fluid

$\Delta h_w$ = inches of water buildup

$\Delta h_F$ = inches of fluid buildup

$\rho_F, \rho_w$ = densities of fluid and water

### Use of Figures

Calculate: Maximum liquid load at bare minimum stability:

1. Determine N, number of caps per square foot of plate area by dividing total number of caps by the cross-sectional area of the column.

2. Determine u, vapor velocity, and $\rho_v$, density of vapor from properties of vapor and temperature and pressure.

3. From plate design and layout determine skirt clearance of caps and number of rows of caps.

4. Determine $h_{ow}$ by, e.g., Kirkbride method, in inches of water.

5. Calculate minimum seal, $S_m$, in inches of water.

6. Compute $u\,\rho^{0.5}$ (7.14/N).

7. From Fig. 31 using value calculated in (6), skirt clearance, and $S_m$ read the value of (GPH per ft./1,000) (No. of rows).

8. Compute average width of plate normal to flow of liquid (arithmetic average of longest and shortest rows of caps).

9. Compute gallons per hour.

10. Compare computed gallons per hour with gallons per hour required for the distillation conditions.

If the computed gallons per hour is less than that required, the plate will be unstable.

If the computed gallons per hour is greater than that required, the plate will be stable.

Calculate: Buildup on plate at inlet weir:

1. Compute u, superficial vapor velocity, feet per second.

2. Determine $\rho$ (vapor), number of caps per square foot, and number of rows.

3. Compute $u\,\rho^{0.5}$ (7.14/N).

4. Determine skirt clearance.

5. Calculate average width of liquid path.

6. Calculate gallons per hour for the distillation conditions.

7. Compute S (minimum).

8. Assume $\Delta h$.

9. Compute $S_{av} = S_m + \Delta h/2$.

10. From Fig. 30 read $\Delta h_l$.

11. Compute $\Delta h$ from Equation 79.

12. Compare assumed $\Delta h$ with computed $\Delta h$.

If the assumed and calculated values agree within 2 per cent, the correct $\Delta h$ has been established. If not, repeat, using new assumed values until agreement is reached.

**Reboiler and condenser design**[204, 32] . . . The design of reboilers and condenser is essentially a heat-exchanger problem. The particular types of equipment used vary with the individual requirements of the system being distilled and

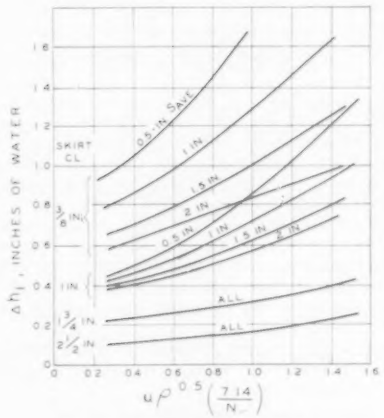



Fig. 30—Liquid buildup correlation.

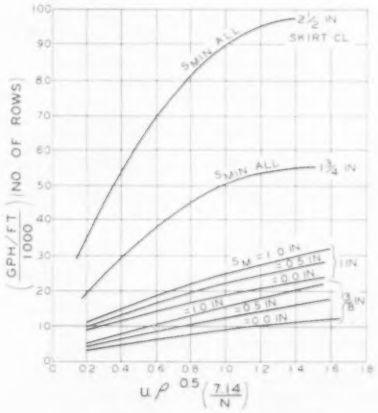



Fig. 31—Liquid capacity correlation.

the heating and cooling medium. In general it is always well to overdesign both reboiling and condenser equipment to allow increase in capacity at some future date and to take care of increasing reflux ratio if the necessity arises.

**Manholes and handholes . . .** Where plate columns are to be used it is necessary to provide access to the plates to change caps and to clean them. For small columns handholes between each plate are suitable. For larger columns (above 3 ft. in diameter) it is necessary to provide manholes at least 18 in. in diameter. (Remember, most plants do not have midgets working in the maintenance crews.)

**Transfer lines . . .** Transfer lines should be so sized that the frictional pressure drop does not increase the cost of operation appreciably or interfere with the column operation. Vapor velocities rarely exceed 30 ft. per second and liquid velocities 2-3 ft. per second.

**Inlet feed manifold . . .** Because of the difficulty of accurately determining the exact feed plate in design calculations it is good practice to provide a feed manifold on the new column having several lines to several plates. This enables the operator to admit the feed on the correct plate and will also allow for changing the feed plate location if the feed composition varies from time to time.

**Insulation . . .** Sufficient insulation must be provided the column, transfer lines, and reboiler to reduce heat loss to a minimum. The quantity and type of insulation varies with the individual system, temperature level, exposure to weather, etc.

**Superstructure and foundation . . .** Adequate ladders and walkways must be provided for fractionating columns so that personnel have access to all parts of the column for inspection and maintenance.

**Instrumentation and controls . . .** All modern columns are provided with instrumentation and control devices so that a close approach to steady-state operation can be obtained. Care must be taken to use the minimum number of automatic controls so that the controls are not bucking one another. Many existing columns would operate much more satisfactorily if some of the nonessential controls were removed.

**Column costs . . .** In computing the cost of a new column it is necessary to use the cost figures on fabricated equipment at the time when the proposed column is to be built. Prices change so rapidly that it almost becomes a crystal-ball type of estimate.

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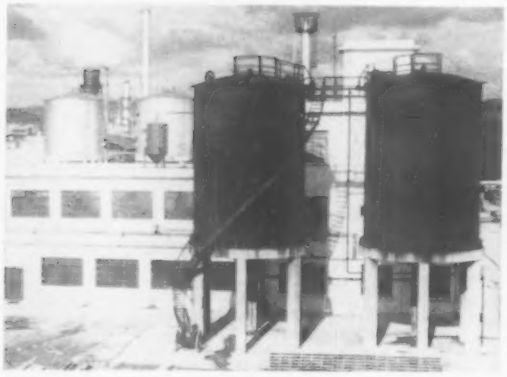
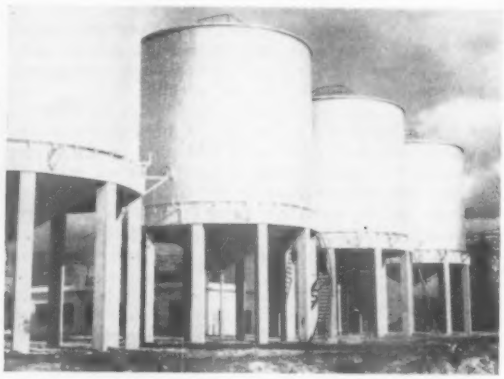
## MAINTENANCE FOR PROFIT

### . . . A Journal Report

**A considerable portion of the refiner's cost of operation is expended on maintenance. This special 30-page Journal report is designed to point up new ideas on how the maintenance job can be done better and at less cost.**



ONLY TWO surge tanks, each of 1,500-bbl. capacity, are used between the MEK and contact units in the lube plant of the Gravenchon, France, refinery of Socony-Vacuum Francaise.



FOUR SURGE TANKS, each of 4,500-bbl. capacity are used between the furfural and MEK units in the lube plant at the Gravenchon refinery. They replace the usual intermediate tanks and pumping facilities.

# A Fresh Look at Maintenance

**Assign capable, experienced people to work on the program, give them intelligent direction and management support, and provide necessary means**

**by R. E. Redfield and V. J. Loyd**

REFINERY-MAINTENANCE costs can be reduced. They can be reduced, that is, if it is a firm management policy to do so. The mechanism by which it can be done has been used time and time again to bring about improvements in other phases of refinery operations. It consists of assigning capable, experienced people to work on the problem; giving them intelligent direction and full management support; and providing them with the necessary means to do the job.

This is exactly what one refinery manager is doing and it is very interesting to look at the problem as he sees it, and to follow his reasoning as he puts his program into effect.

Bill manages the Western refinery of Mythical Oil Co. He is recognized in the industry as being capable and progressive. He has given much thought to maintenance costs, which in his refinery represent about 30 per cent of the total direct operating cost. Being a good manager, he has worked on his fuel costs, so that maintenance represents the last major expense item which he believes can be substantially reduced.

Both Bill and his staff have many good ideas about reducing maintenance costs, but with the constant pressure of day-to-day work very few of the ideas are getting translated into reality. Bill knows from his own experience that anyone in a line position does not have sufficient time to work on them effectively. And he realizes that his plant engineering department is continually loaded with work on which he has already established priorities. So, after much study and discussion, Bill works out a plan of action and puts it into effect.

**Maintenance plan . . .** He selects a few capable engineers with well-rounded refinery experience, and establishes them as a staff group, reporting directly to refinery management. He makes provisions for them to have access to all maintenance records, work orders, detailed cost breakdowns, and all the other data which he feels they will need to do an effective job. For want of a better name, he calls them the Maintenance Cost Reduction Group, which soon is shortened to MG. He visualizes this group as a "technical department" for the mechanical phase of his refinery operation.

At a general meeting of his super-

**THE AUTHORS**

R. E. REDFIELD

V. J. LOYD

**Robert E. Redfield, maintenance engineer in the refinery-engineering department of Socony-Vacuum Oil Co., Inc., has been associated with the company since 1934, starting as a technical advisor. After serving as technical advisor of the company's European refineries for several years, he became project engineer in the refinery engineering division in 1942. From 1945 to 1952 he was general manager of refineries for Socony-Vacuum Francaise. He assumed his present position of maintenance engineer of the refinery engineering department in New York in October, 1952. A native of Livingstone, Mont., Redfield attended Montana State College.**

**Vernon J. Loyd, Socony-Vacuum engineer, joined the company in 1936 as a laboratory tester. He served as unit fireman, loader, chemist, construction engineer, maintenance engineer, and maintenance superintendent, all at the East Chicago refinery. Then in 1951 he transferred to the refinery engineering division in New York as engineer. Loyd is a graduate of Iowa State College with a B.S. degree in chemical engineering.**

visory staff, Bill explains the status and functions of the MG. They are charged with the responsibility of bringing refinery mechanical activity to a high degree of effectiveness, and keeping it there. This will entail studies and recommendations concerning all factors bearing on efficient work performance. And it will include concurrent studies of ways and means to substantially reduce the refinery work load by making additions, alterations or replacements of equipment so that one-time expenditures will eliminate or reduce constantly recurring maintenance work.

Bill explains that in making studies the MG will work closely with all refinery groups, since he fully expects that their work-reduction efforts will often take them out of the realm of pure maintenance. He asks the support and cooperation of the maintenance, engineering, operating, technical, and accounting departments in working with the MG toward over-all refinery benefits.

Bill states that he will take a dim view of proposed changes which do not show reasonable payouts, but that he is prepared to support major expenditures to achieve the objectives of the program if such payouts are shown. In answer to a question, he agrees that for processing units the realization lost while the unit is offstream for turnaround is a justifiable factor in figuring payouts for changes which will reduce downtime.

As a parting shot, Bill explains that the MG is to attack each project with the idea of eliminating work. If that is not possible, they will try to simplify it, and recommend means of doing it more efficiently. They are not to accept blindly practices or precedents whose origins are lost in the past. Indeed, any practices which have not been improved during the past 5 years are to come under immediate scrutiny.

In closing, Bill states that the MG are not to intervene or become involved in any way with work going on in the refinery. Any proposed changes will be adopted only after full discussion with everyone concerned, and instructions will be passed down the line through regular channels after approval by the manager.

**Practical approach . . .** Here we will leave Bill for a few moments to make some comments about his program. We think he has made a very practical approach to the problem. Certainly if constructive work is to be done there must be capable people who have the time and means to do it. We like very much his emphasis on efficient work performance. Improvement in that field is the key to very substantial savings. It is the sphere in which practically all maintenance improvement programs have been concentrated during the past several years.

Witness the continued emphasis on employe and supervisory training, on work planning and scheduling, on tools and shop facilities, on more effective supervision, on transportation and mobile equipment, and on all the other factors which relate directly to efficient work performance. Surely the MG can make a showing in this field.

We are also very much taken with Bill's emphasis on reducing the work load. We like to see work performed efficiently, but are much happier if it can be totally eliminated. We expect to hear much more about this.

We think Bill's insistence on a questioning attitude for the MG shows superior insight. We predict that they are going to bring to light many strange situations, and that the maintenance savings gained by the improvements which they recommend will be greatly overshadowed by the over-all benefits derived from them.

Now we will return to Bill again. He is meeting with the MG, and has just finished outlining his thoughts on maintenance work performance. He has a list of methods and practices which have proved out in other refineries and which he wants studied for local application.

**Reducing work load . . .** Bill now turns to the subject of reducing the plant work load. He starts out with maintenance costs on processing units, noting that they represent about two-thirds of the total plant-maintenance expense. And, as they all know, turnarounds account for the major portion of those costs. When a unit is down for turnaround, the work load goes up, maintenance costs go up, and realization from the unit takes a sharp downward swing. This distasteful situation gives rise to Bill's initial assignment to the MG in the field of work reduction:

**Double the length of runs between turnarounds for all processing units.**

After recovering from their initial shock, the MG asked Bill for some ideas as to how he thinks this can be done. He reminds them that on most units there are repeat offenders which limit the length of runs. In one case it may be fouling of heat exchangers; in other the heater may coke up; in still another it may be fouling overhead condensers. Some times corrosion or erosion are limiting factors, and units are brought down for inspection. In any event, units are shut down for specific reasons. Bill suggests that the MG review the history of each unit, determine the cause or causes of shutdowns, and then work up corrective recommendations for each limitation.

**Heater shutdowns . . .** In the cases where heaters cause shutdowns he has more to say. Heaters as a class of equipment are apt to be subjected to the most abuse in the refinery, and as a result are responsible for very many unit shutdowns. It is common practice to crowd oil through a heater and fire it at excessive rates until it cokes up or a tube fails. Refractory repairs are usually a standard item on every turnaround work list. Now, Bill says, the dollar return from high throughput on the unit may justify operating that way, but he wants to be sure. There are three possible courses to follow:

1. Continue to operate at high throughput and excessive firing rates and keep on paying the penalty of short runs and high maintenance costs.

2. Drop back on throughput and operate the heater at rates consistent with maximum runs and minimum maintenance.

3. Continue to operate at high throughput but revamp or enlarge the

heater in line with the duty required of it to again achieve maximum runs with minimum maintenance.

The MG is to take into consideration all possible factors, and determine what heater operation is the most economical for each unit.

In cases where runs are limited because of fouling of heat exchangers or condensers, Bill wants the MG to study the economics of installing spare equipment so that cleaning and repairs can be carried out while the unit is on stream.

If corrosion or erosion are limiting factors, Bill wants effective control measures studied and evaluated for the best solution. In the present state of the arts, Bill is sure that neither corrosion nor erosion should constitute a bar toward the goal of doubling unit runs.

**Ideal situation . . .** In summing up, Bill visualizes the ideal situation—processing units so designed and constructed that they will operate for long periods of time, and yet not require prolonged turnarounds for extensive repairs or replacements. It is by going in this direction that he hopes to arrive at minimum maintenance costs in his refinery, and at the same time enjoy the maximum possible realization from his processing units.

We will now leave Bill. We have the gratifying feeling that here is a man who is well on his way to realizing a solution to his maintenance problems.

There are, of course, many additional studies which can be made by maintenance-reduction groups, depending on existing conditions. We are going to suggest a few of them. If they seem to range far afield from strict maintenance considerations, it should be remembered that the primary objective is the elimination of maintenance work. This calls for broad and progressive thinking on the part of all concerned. In many cases realization of the objective may be limited in existing refineries, but the principles involved should be given full consideration whenever new construction is undertaken.

**Steam systems . . .** Consider, for example, steam-distribution systems, and the use of steam-driven equipment. Most refineries have extensive loop systems of intermediate and low-pressure steam in the process areas, with one or both systems extending to the tank farms. The work effort required to maintain steam pumps and the maze of steam piping, valves, and traps is not often fully appreciated, but it is an ever-present and continuous part of the work load of the maintenance department.

Therefore anything which can be done to minimize such work should be given serious study. Our approach to this problem is not what is the best way to repair leaks or to maintain traps, but how can the steam lines and equipment be eliminated in every case where it is profitable to do so.

Tank heating by steam should be studied to arrive at the minimum situation, both as to use of steam, and piping required. The maintenance of long steam lines to provide for isolated pumps or for heating small buildings should be looked into. In unit areas the maintenance of complex steam supply and exhaust loops for seldom-used steam standby equipment should be given thorough study in the light of existing conditions.

Motor drives are generally more economical to operate, and maintenance costs for motors and the electrical distribution system are only a fraction of that for steam drives and the necessary steam loops. In these days of rare power outages, reason might well dictate that the only steam standby equipment required is that which is necessary to bring a unit down safely.

What we have just said does not imply that we think that steam power has no place in the refinery, for there are many instances where steam is the proper and only answer. But what we do say is that steam is an expensive utility, and that steam lines and steam-driven equipment represent an omnipresent source of maintenance expense. We say, therefore, that steam should be used only where there is no better and cheaper means of doing the job.

**Intermediate tankage . . .** Carrying on with the idea of reducing maintenance costs by eliminating the necessity for maintenance, we come to the subject of eliminating intermediate tankage with all the related piping and pumping facilities. In a modern refinery it is not uncommon to pump all products from the processing units through the light-oil treating plant and on to finished storage. A study of the unit itself may very frequently indicate the possibility of eliminating part or all of the intermediate stock tanks. Maintenance expenses of these tanks and the related piping and pumping equipment can be largely eliminated if the tanks are taken out of service.

The policy of eliminating intermediate tanks can be carried further in lube-oil plants. Several installations have been made where the lube-oil processes are connected with only intermediate surge tanks, with the four to five processing steps operated as a single unit. This practice in one instance resulted in taking out of service 200 intermediate tanks, together with the corresponding piping and pumping facilities. This elimination of intermediate tanks represents a progressive step in the reduction of maintenance costs by elimination of the necessity for maintenance.

**Cleaning refinery equipment . . .** Or, let us look at the problem of cleaning refinery equipment. Towers and heat-exchange equipment present a universal problem which can well be afforded much intelligent study. Chemical cleaning of towers and tubular equipment represents a field which we feel has scarcely been touched from a technical standpoint in most refineries. The investigation of all possible methods of in-place chemical cleaning should be carried on in an intelligent manner, as this presents another means of making an appreciable reduction in the refinery work load.

Once a staff maintenance group such as the MG is set up, the profitable work which can be done is almost endless. Work orders can be examined with a view to making one-time repairs whenever possible. Long-range work can be carried out on equipment standardization, with the idea in mind of appreciably reducing storeroom stocks, and yet assuring that necessary parts are always available. Shop facilities, tools, transportation, communication, work methods, and other subjects bearing on the efficient performance of maintenance work should be studied in each plant, preferably by a group such as the MG who have the time and ability to do an effective job.

What such a group is called, or where it best fits in the refinery organization, is not too important. What is important is that it does exist and is functioning, and that work is always being done in the field which promises the greatest benefits in over-all refinery realization.

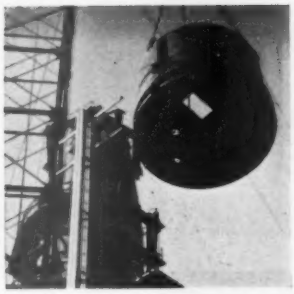
> "... the primary objective is the elimination of maintenance work. This calls for broad and progressive thinking on the part of all concerned. In many cases realization may be limited . . . but the principles involved should be given full consideration whenever new construction is undertaken."

## Rock Island Refinery

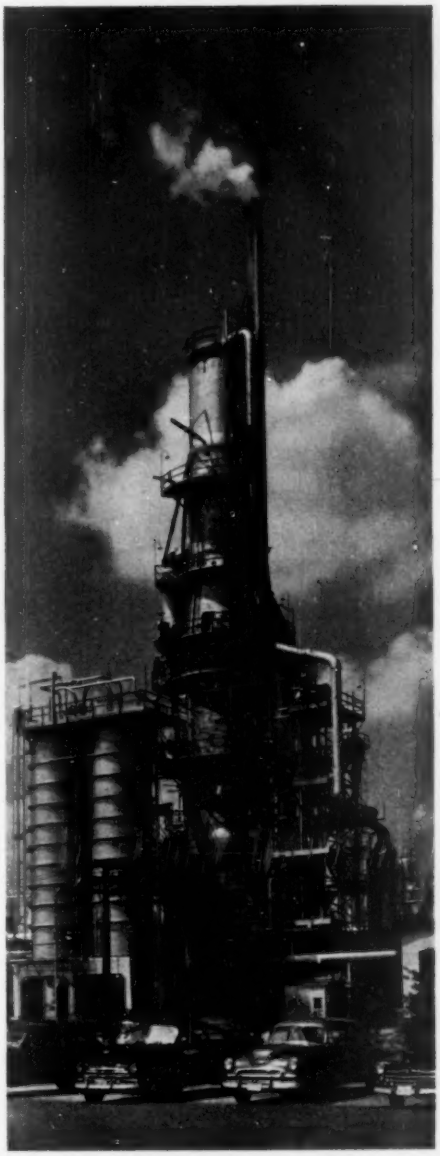
# MODERNIZATION

## brings GREATER YIELDS

## from Crudes



*Left: Erection view of the fluid catalytic cracker at the Rock Island Refining Corporation's Zionsville, Indiana refinery.*



When Rock Island Refining Corporation modernized their Zionsville, Indiana refinery, they naturally installed efficient, high capacity equipment . . . equipment that would help them produce the highest practical yields from every barrel of crude oil.

The new U.O.P. fluid catalytic cracking unit shown at the right was chosen because it embodies many advanced operating techniques. It has a rated capacity of 5,000-bbls. per day, and replaces a thermal cracker-reformer which was converted to crude distillation service. The building of several important units for the fluid catalytic cracking unit — the 8-ft. by 79-ft. 6-in. crude unit fractionator, the 6-ft. 6-in. by 85-ft. 8-in. main cat cracker fractionator, two 11-ft. 6-in. by 40-ft. catalyst hoppers, and the reactor generator — was done by the Chicago Bridge and Iron Company. In addition, we also supplied the refinery with two processing towers, a group of cone roof tanks, a Horton Vaporsphere, a debutanizer relief drum, and a water settling tank.

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MAINTENANCE PRIORITIES COMMITTEE meets regularly. Left to right are: H. W. Jouette, mechanical superintendent; M. B. Tohline, assistant chief engineer; C. D. Marshall, assistant technical director and committee chairman; Arthur Knippel, head of the planning and scheduling; and Otos Branson, process superintendent.

## How Magnolia Operates Its

# MAINTENANCE PRIORITY SYSTEM

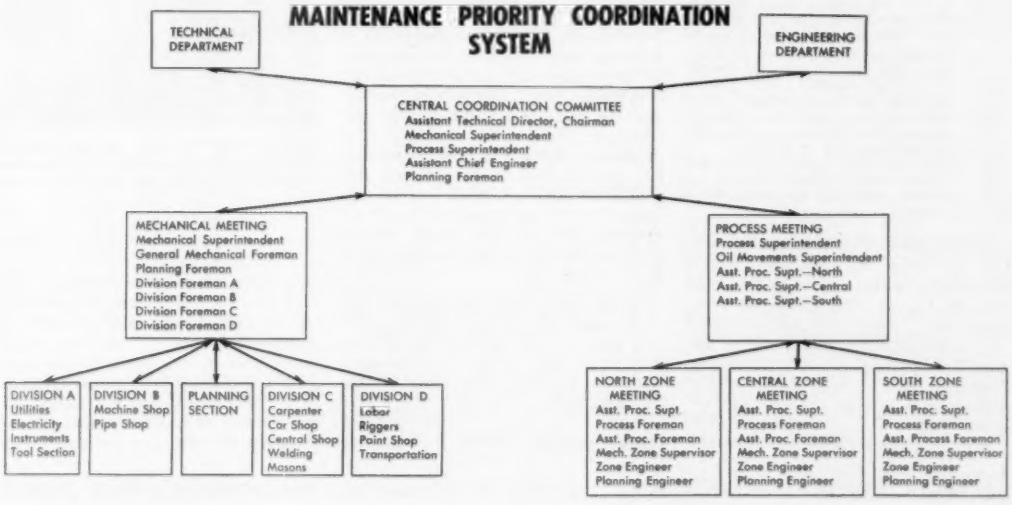
**by F. Lawrence Resen**
Gulf Coast District Editor

"FIRST THINGS FIRST." This might be the slogan of the central coordinating committee at Magnolia Petroleum Company's Beaumont, Tex., refinery, which is responsible for priority listings of all maintenance and construction jobs requiring plant personnel.

The committee, whose job it is to review all proposed work requests and then assign priority classifications to each item, uses a numerical-alphabetical designation for each plant job, which information is then used by the mechanical department for assigning available personnel to the best advantage.

Officially charged with the systematic and orderly progress of maintenance and construction work consistent with sound safety policies and fulfillment of plant production commitments, the group functions as a high-level clearing house among all plant departments.

With representatives of mechanical, engineering, process, and technical departments as full-time members the committee makeup is such as to elimi-



**REPAIR OF KETONE FILTERS, along with other work on processing equipment temporarily out of service, rates high consideration in priority settings.**

**MACHINE-WORK priorities are tied in closely with the over-all needs of the refinery. This is a radial drill in the plant's machine shop.**

nate overlapping of projects, and to provide for a better, centralized over-all planning program.

The committee meets daily to receive information channeled through the mechanical and operating departments and makes its evaluation as to importance of the various projects. On the basis of its listing, schedules are then drawn up for the following day's work in all of the mechanical groups.

**Priority classifications . . .** Jobs are classified according to importance by a combination of first alphabetical and then numerical designations. In the alphabetical class, jobs are broken down to fall into one of four classifications:

- AA Jobs of an emergency nature that must be worked due to extreme conditions. This does not necessarily apply to emergency work orders but to emergency jobs that are important enough to warrant overtime. This priority should be used very sparingly.
- A Jobs that must be worked; that are essential for maintaining production and safe operation of the plant.
- B Work that should be carried on but of less essential nature.
- C Backlog work and jobs that can be done during bad weather.

Prefix numbers are then used to indicate the order of importance within the given priority; i.e.—1A, 2A, etc.; 1B, 2B, 3B, etc., the 1A having preference over 2A and all higher numbered "A" items, with the same order of importance applying to the "B" group. Naturally, all "A" items have a higher priority than any of the "B" or "C" group, etc.

While all classification will naturally depend on the daily operating situation at the plant, typical classifications might find (1) Furnace tube failure on a pipe still requiring emergency or AA listing; (2) a turnaround listed as "A" since it must be completed as soon as possible to get unit back on stream; (3) the less-essential chlorinator installation on the river-water system falling into the "B" group; and, (4) the salvaging of an old line in the alkylation unit listed under the "C" heading.

**No limitations . . .** In the breakdown of projects according to priority classifications, no limitation is placed upon the number of "A," "B," or "C" jobs. However, from a practical standpoint, the number of "A" classifications are limited according to the work load. For instance, if a major turnaround is in progress, the number of personnel in the various crafts not engaged in the turnaround would naturally be limited, and this would, in turn, govern the personnel available for other "A" classifications. Since it is the purpose of the classification to list all jobs desirable to work on the following day under "A," if the personnel won't be available, the "B" list would be the larger of the two under such a situation.

On the other hand, should only relatively small jobs be listed under "A," it is quite natural that the list will be long since many of the small projects can be completed in the normal work day coming.

**Higher priority . . .** When a project receives an "A" classification, it is not a foregone conclusion that it will gradually work up the priority listing until it is "1A." If it is a small job, and has, say an 11A classification, it might be completed before a "1A" job which would take much longer. At the same time, the identical job first classified as "11A," but which was not begun, for one reason or another, might be reclassified "C" due to a decision to in-

**INSULATION WORK is covered under the system by which establishment of priorities extends to both big and little maintenance jobs.**

clude it in a turnaround schedule a month or more away.

In like manner, a "C" classification doesn't necessarily mean it has to work itself up the "priority ladder" past all of the "B" listings before being started. An important job could easily be held up due to delay in shipment of materials, and by keeping it on the "C" list, it is not overlooked and at the same time does not confuse the priority picture. Upon receipt of the necessary material, it can easily jump to a high "A" rating.

The craft foreman, meanwhile, can use the priority listings in their daily assignment of personnel in their charge. They would first assign men to the particular jobs according to priority ratings: 1A, then 2A, then 3A, etc. Once these requirements had been fulfilled, the remaining men would follow up on the "B" projects, again using numerical order. Under normal circumstances, it would be seldom that they worked on the "C" listings, unless inclement weather or an extremely slack period was experienced. Otherwise, the "C" listings, usually the smallest of the three lists, work into a higher classification.

**Typical list . . .** The following examples of the way priorities jump from zone to zone is typical of the workings of the system. However, shortened lists are shown here, with the "A" and "B" groups terminated at 10 for each zone. The actual lists vary considerably in length, but for the particular day from which these examples were taken, the "A" list included 48 projects, the "B" list included 85, while there were 9 "C" listings. Interestingly enough, on this particular day, the previous "C" listing of "Wax Mold Building—fabricate and install platform with handrail," was changed to 17A at the coordinating committee meeting.

However, while the committee finalizes the priority listings, preliminary suggestions are made by operating zone groups and mechanical department which form the nucleus around which the coordinating committee operates. The preliminary planning is done on the operating level, and a tracing through of the daily routine will clarify the functioning of the system.

**Operating zones . . .** At Magnolia, the operating areas are broken down into three zones; on a geographical basis: North, which contains mainly cat cracking facilities; Central, which primarily includes lube-oil-manufacturing units; and South, where light ends units are located. To each of these zones is assigned an assistant process superintendent. Each morning, the assistant process superintendent attends a zone meeting along with the process foreman and assistant process foreman for the zone, mechanical zone supervisor, zone engineer, and a planning engineer.

**TYPICAL MECHANICAL DIVISION PRIORITY LIST**

(Arranged according to Plant Zones)

**North Zone**

| | |
|---|---|
| AA | Safety on all jobs. |
| 1A | Comb. Unit—vis breaker turnaround |
| 1A | Swt. No. 9—T.P. No. 1—clean and repair |
| 3A | TCC 3—clean exchs. 547 and 548 and rep. overhead condenser No. 550 |
| 4A | TCC 4—repair passenger elevator |
| 7A | TCC 3—rep. stab. feed pump 1992 and stab. reflux pump No. 1868 |
| 8A | Gas Plant 4 North—repair pump No. 1748 |
| 1B | Lt. Oil Agit.—water spray system |
| 2B | Gas Plant 4—install chlorinator on river water system |
| 4B | Pump Hose No. 3—install walkway to 734 manifold |
| 6B | Tool Section—replace roof |
| C | Cafeteria—fab. and install steam table |
| C | Loading Rack 1—repair decking |
| C | Sweetener 5—install flow meters in outlet lines |
| C | Tk. Farm—install monuments to mark location of buried deposits of tetraethyl lead |

**Central Zone**

| | |
|---|---|
| AA | Safety on all jobs |
| 2A | Furfural No. 1 turnaround |
| 5A | Pipe Still 5—lines and tank changes for microclay wash |
| 6A | P.S. 11—repair kerosine cooler No. 174 |
| 9A | Vac. Still 2—install feed return and product lines |
| 9A | Vac. Still 2—install lines and pump |
| 9A | Vac. Still 2—install lines and control equipment |
| 5B | Gr. Plt.—remove, clean, repair exhaust fan on second floor |
| 7B | Tk. 624—connect 4-in. light-lube-oil line |
| 9B | Ketone 1—overhaul compr. G-15A |
| C | Wax Mold Bldg.—fab. and install platform with handrail |
| C | Tk. 1233—clean stairway |
| C | Tk. 625—clean stairway |

**South Zone**

| | |
|---|---|
| AA | Safety on all jobs |
| 10A | G.P. 3—rep. south steam still preheater No. 89 and reboiler No. 92 |
| 3B | Pipe Still 10—renew B.O. water inlet line to barometric |
| 8B | Tk. 2121—salvage 8-in. gas-oil line and 8-in. No. 10 line |
| C | Alkylation area—salvage 4-in. paraffin line |
| C | Alkylation area—fab. valve wrenches |

Purpose of the meeting is to review the list of jobs suggested for the following day within the particular zone. Deletions are made to today's priority list wherever necessary when jobs have been completed or are expected to be completed the day of the meeting. The progress of key jobs is checked into and the need for the jobs to be continued is evaluated in the light of current situation. For instance, installation of a new pump may have had a high priority the previous day. However, while the original work order called for the rounding off of corners on the foundation and the waterproofing of same, it was not possible to complete this the previous day. As a follow-up job, not of the same importance as the pump replacement, the foundation work would no doubt end up with a lower classification; i.e. "B" or "C."

At the same meeting, new jobs suggested within the zone are discussed and a decision as to the desired alphabetical classification for each is reached. The list thus arrived at is sent on to the mechanical department as a tentative priority list.

**Mechanical meeting . . .** A second meeting within the mechanical department takes place which is attended by the mechanical superintendent, the general mechanical foreman, the planning foreman, and the four division foremen in charge of the various crafts. Purpose of this meeting is to tie in all of the zone requirements with the planning of the mechanical department. This meeting is purposely kept small for easier handling and information discussed filters down to the lower echelons.

A routine similar to that of the zone meetings is followed here: priority lists are checked for jobs completed, other projects are evaluated and reclassification recommended, if necessary, and new jobs sent in from the various zones are reviewed and suggested priorities passed upon.

Since the mechanical department is concerned with the actual work involved in completing the desired jobs, it is mainly concerned with the particular personnel and equipment required by the project. If two similar jobs in different zones were to require more personnel than was available in one particular craft, and both had been listed as "A" at the zone meeting, the mechanical department meeting would request clarification on this matter so as to be able to properly schedule the crafts.

**Process department . . .** The tentative priority list from the mechanical meeting, with alphabetical classifications would next be passed on to the process meeting, attended by the process superintendent, and four assistants. At this

*(Continued on page 253)*

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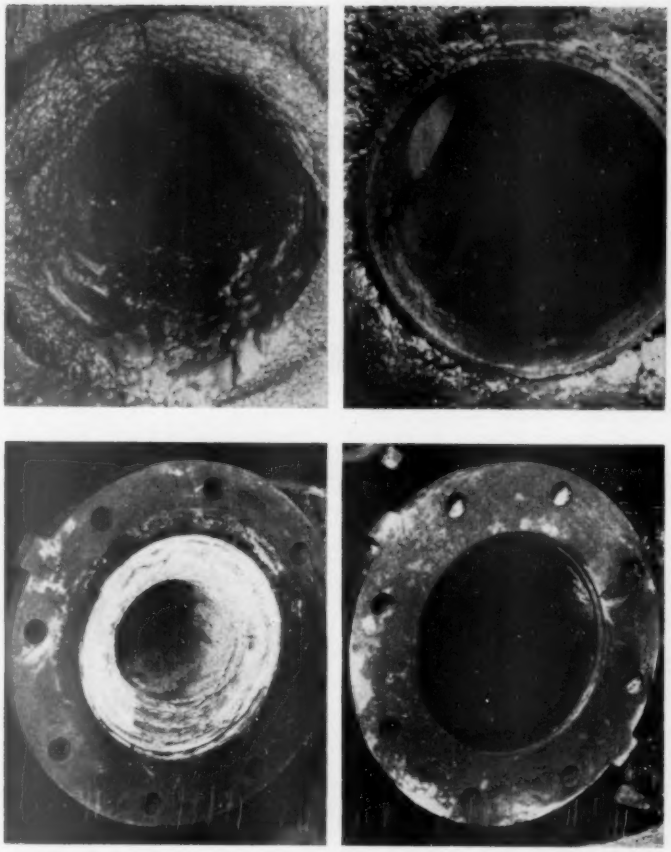


**BEFORE . . .** **AFTER . . .**

**Near 100 per cent effectiveness may be realized in cleaning refining equipment with chemicals. Top left shows scale deposition in a water-tube boiler. Top right shows same boiler after chemical cleaning. Middle left shows deposit in a refinery water line. Middle right shows same line after cleaning. Lower left shows deposit on tubes in an open-box cooler. Lower right shows same tubes after cleaning. Similar results can be obtained on most heat-exchanger equipment.**

*Here's a "How To" Primer on*

# Chemical Cleaning of Refining Equipment

**by Gerald L. Farrar**
**Engineering Editor**

**For best results, chemical cleaning should be a matter of regular routine. Scale deposition should not be allowed to build up too far, for as scale thickness increases, composition becomes more complex, and harder to dissolve.**

REMOVAL of surface scale, deposits, and impurities from metals by immersion in acid or other suitable solvent is commercially feasible. This chemical cleaning is a safe, useful maintenance tool, as long as the operators know what they are doing.

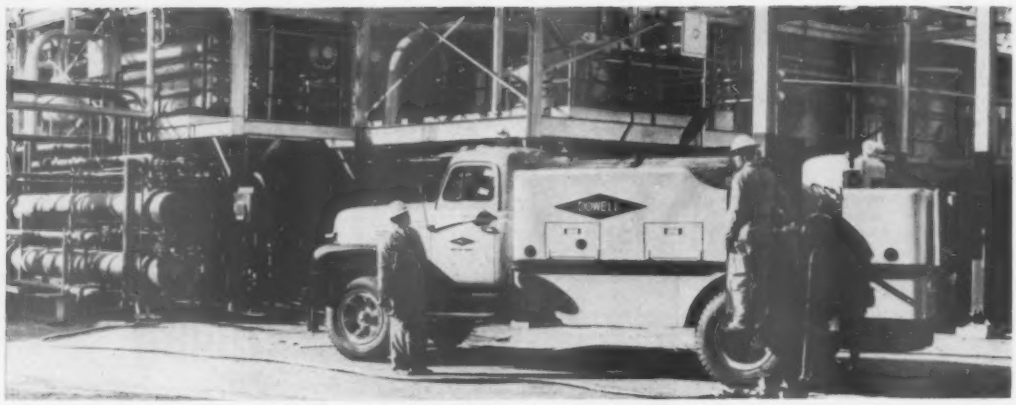
If qualified personnel with proper experience are available, chemical cleaning is more economical than other maintenance procedures. Cleaning jobs often pay for themselves within a week or a month.

The chemical-cleaning method is made feasible by the addition of inhibitors which prevent attack of the base metal, but permit rapid solution of the scale. Several potent inhibitors, each specific for a particular type of cleaning, are available. Other additives are also used when required.

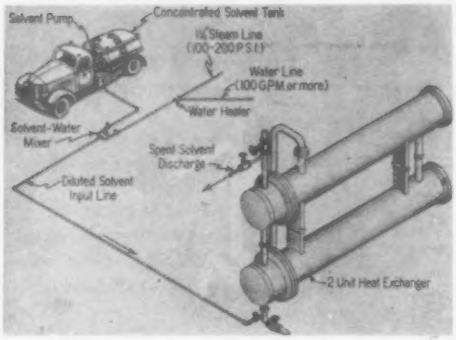
Cleaning procedures have been developed which give solvent concentrations, temperatures, and time intervals to be used on each type of metal under given scaling conditions. For example, it is possible to chemically clean steel with 99 per cent effectiveness in preventing metal corrosion, using a specific inhibitor.

It should be pointed out, however,

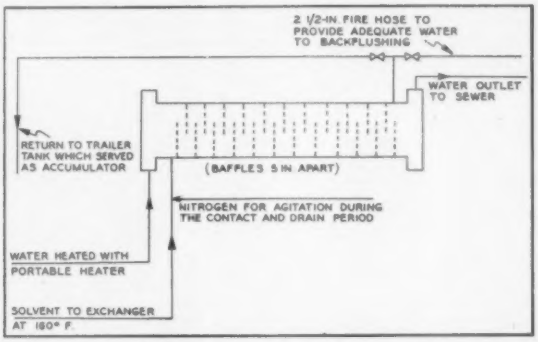
Data and information for this article were supplied by Dowell Incorporated, Tulsa.



CLEANING TRUCK on location cleaning a refinery exchanger.




SCHEMATIC DIAGRAM of hookup for cleaning typical heat exchanger system. Fig. 1.


2 1/2-IN. FIRE HOSE TO PROVIDE ADEQUATE WATER TO BACKFLUSHING
WATER OUTLET TO SEWER
RETURN TO TRAILER TANK WHICH SERVED AS ACCUMULATOR
(BAFFLES 5 IN APART)
NITROGEN FOR AGITATION DURING THE CONTACT AND DRAIN PERIOD
WATER HEATED WITH PORTABLE HEATER
SOLVENT TO EXCHANGER AT 180° F.

PIPING ARRANGEMENT for cleaning exchangers without circulating solvent. Fig. 2.

that chemical cleaning will not work in every case. Success of cleaning depends on scale composition and condition. When an exceedingly insoluble scale is encountered, use of mechanical tools may be more practical in some instances.

Chemical cleaning will be cheaper and more satisfactory in the long run if scale deposition is not allowed to build up too far. As scale thickness increases, composition becomes more complex, and solubility in a given solvent usually decreases. Thus, chemicals are cheaper and time off stream is less if intervals between cleanings are not too great.

If cleaning of exchanger tubes is delayed too long, the tubes may be plugged solid. Cleaning with chemicals then becomes impossible, since the solvent cannot flow through the tubes.

### Deposits and Scale

In chemical cleaning of refinery equipment, scale and deposits are arbitrarily divided into three classes for purposes of identification and choice of general cleaning procedure. These are inorganic, organic, and mixtures of the two.

**Inorganic deposits . . .** Inorganic depositions consist of a comparatively small number of specific chemical compounds, each of which may be identified by analysis. Each compound is composed of positive ions (cations) and negative ions (anions). Metal cations present in the scale must of necessity have come from the equipment itself or from metals present in the fluids passing through the equipment. The anions will have come from the fluids themselves.

For example, if water is used as cooling medium in a heat exchanger with cast-iron channel sections and tubes of copper alloy, the metals which may be expected to be present are (1) iron, (2) copper, (3) zinc, (4) potassium, (5) manganese, (6) sodium, (7) magnesium, and (8) calcium. Anions which may be present are (1) carbonate, (2) bicarbonate, (3) sulfate, (4) chloride, (5) sulfide, (6) oxide, (7) hydroxide, and (8) silicate.

Deposits, then, may be expected to contain some or all of these water-insoluble carbonates and bicarbonates: (1) iron, (2) copper, (3) zinc, (4) magnesium, and (5) calcium. These deposits are removed, as are inorganic deposits in general, by converting the compounds from insoluble ones to those which are soluble in the cleaning solvent. Hydrochloric acid reacts with the carbonates thusly:

$$MCO_3 + 2\,HCl \rightarrow MCl_2 + H_2O + CO_2$$

M refers to the metal cation.

The metal chloride is soluble in the solvent, while the $CO_2$ is evolved as a gas. Insoluble **calcium sulfate,** another compound to be expected in some scales, is very difficult to remove, since it is for all practical purposes insoluble in hydrochloric acid. Alternate treatments of acid and alkali are some-

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times successful in effecting removal. Hot, strong caustic solution has been used in some cases, but this treatment is usually not economical, and handling of hot caustic is dangerous.

Calcium sulfate is rarely found in heat-exchange equipment. It is more prevalent, however, in boilers.

Insoluble metal oxides which may occur in the scale are those of (1) iron, (2) copper, (3) zinc, and (4) manganese. Hydroxides of these metals may also be expected. These compounds are usually removed by treatment with hydrochloric acid, although the reaction is somewhat slower than the reaction with metal carbonates. A typical reaction proceeds as follows:

$$M_2O_3 + 6\,HCl \rightarrow 2\,MCl_3 + 3\,H_2O$$

Again the metal chloride is usually soluble in the acid medium. Cuprous oxide is rather insoluble in dilute hydrochloric acid, however. When manganese dioxide dissolves in HCl, free chlorine is liberated. This compound is of course very corrosive.

When this metal is detected in the scale, suitable reducing agents can be added to the solvent to react with the manganese and prevent the formation of chlorine.

Metal sulfides which are insoluble and thus may be expected in some scales are those of (1) iron, (2) zinc, and (3) copper. These sulfides usually dissolve in hydrochloric acid as follows:

$$MS + 2\,HCl \rightarrow MCl_2 + H_2S$$

Hydrogen sulfide is evolved as a gas, and as explained later proper precautions must be taken. Copper sulfides are relatively insoluble, as are zinc sulfides except under carefully controlled conditions.

Insoluble silicate deposits may include (1) iron, (2) copper, (3) zinc, (4) manganese, (5) magnesium, and (6) calcium silicates. These silicate deposits are very difficult to remove. Hydrochloric acid containing fluorides and other additional agents is sometimes used. Hydrofluoric acid is generated in this manner. Silicates are soluble in this material.

Another method sometimes used for removal of silicates involves alternate treatments of acid and alkali. Choice of method should be based on laboratory tests or the experience of the maintenance engineer.

If chemicals such as phosphates and chromates are added to the water to soften it or to make it less corrosive, the cations and anions of these compounds may also be found in the scale.

**Organic deposits . . .** The organic deposits found on the process side of equipment in oil refineries consist of a great variety of chemical compounds. The nature and composition of these materials depend on such factors as temperature, pressure, and nature of the processed stock. Refinery deposits vary from volatile fluids to hard, coke-like deposits. The latter may be almost completely insoluble in the solvents usually used in chemical cleaning.

Organic deposits are usually removed from refining equipment by solution in organic or chlorinated organic solvents, without chemical change. Dispersion of the deposits in suitable aqueous solutions may also be used. When chemical treatment is required, (1) treatment with strong sulfuric acid, (2) solution in strong alkali, or (3) use of strong oxidizing agents in either strong alkali or strong acid solutions may be indicated.

**Mixtures . . .** Inorganic deposits mixed with oil or grease are often found in water and steam systems. Too, organic deposits usually contain some inorganic material. Most refinery organic deposits are mixed with iron and copper sulfides.

When this condition is encountered, it is often found advisable to use an emulsified solvent containing both inhibited acid and organic solvent. This is shown in a later example.

### Sampling and Analysis of Scales

A chemical cleaning job should never be undertaken until the scale or deposit has been sampled and its composition determined. Great care should be taken in the sampling. The sample should represent that portion of the scale that is hardest to remove. Scale samples from heat exchangers should be taken from near the inlet or outlet, wherever the heaviest deposits are formed. A boiler-scale sample should be from the hardest scale in the boiler, and is usually taken from the hottest tubes.

The scale sample should be removed down to the bare metal. When possible, a small section of tube containing the scale should be procured. Otherwise, an effort should be made to obtain the sample in chunks. However, powdered-scale samples are helpful if tube samples or chunks cannot be obtained.

**Analysis . . .** A visual inspection is first made of the scale sample. Such factors as thickness, density, porosity, and type (whether the scale consists of layers of different substances, or whether the material is homogeneous) are determined in this examination.

If warranted, the scale sample may be analyzed by the X-ray diffraction technique. This analysis will ordinarily identify the specific chemical compounds appearing in the material. Only a small amount of sample is required, and the sample is not destroyed in the process. In rare instances it is not possible to identify completely the chemical compounds present by X-ray. In these cases an additional spectroscopic analysis is used.

Solubility tests are made to indicate the proper solvent, required time, optimum temperature, and best manner of solvent application. One of three test methods is generally used:

1. Quantity of gas generated by action of excess acid on a given weight of sample is measured.
2. A weighed sample is placed in an excess of acid solution. Reaction is allowed to reach completion. Residue is weighed after washing and drying. Solubility is determined from the difference in weight.
3. A measured volume of sample is placed in an excess of acid solution. After completion of reaction, loss in volume is calculated. Solubility is determined from the difference in volume.

### Solvent Selection

Suitable solvents for the cleaning job at hand can be selected, once the physical and chemical characteristics of the scale or deposit are known.

Muriatic acid (commercial hydrochloric acid) of 28 to 32 per cent hydrogen chloride by weight is usually used as the solvent base. To this acid are added special inhibitors, catalysts, wetting agents, intensifiers, and reaction-control agents, depending on the type and condition of the deposit.

**Use of inhibitors . . .** Chemical cleaning as it is now practiced would be impossible without the use of inhibitors. The most effective inhibitors contain arsenic, sulfur, or nitrogen, in combination with organic compounds.

Certain inhibitors are specific for certain metals. In systems where more than one metal is present, this must be taken into account. For example, in a heat-exchange system, low-carbon-steel pipes, copper-alloy tubes, and cast-iron headers may be employed. A properly inhibited solvent will not cause dezincification of admiralty metal, since both copper and zinc are dissolved uniformly.

**Expediting agents . . .** Other agents are added to the cleaning solvent from time to time as needed to speed up the reaction or take care of certain aspects of the cleaning problem. Foaming agents may be added to agitate the so-

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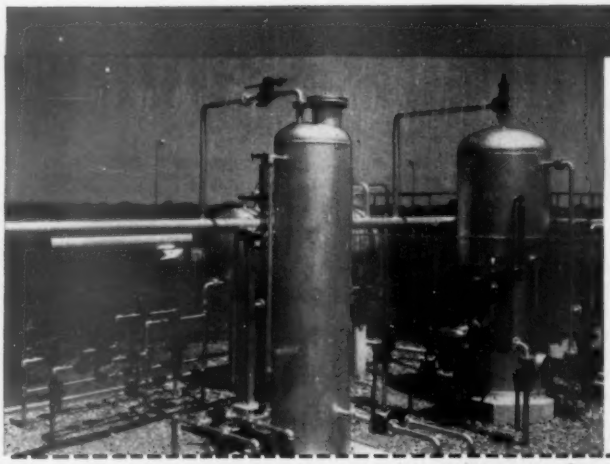

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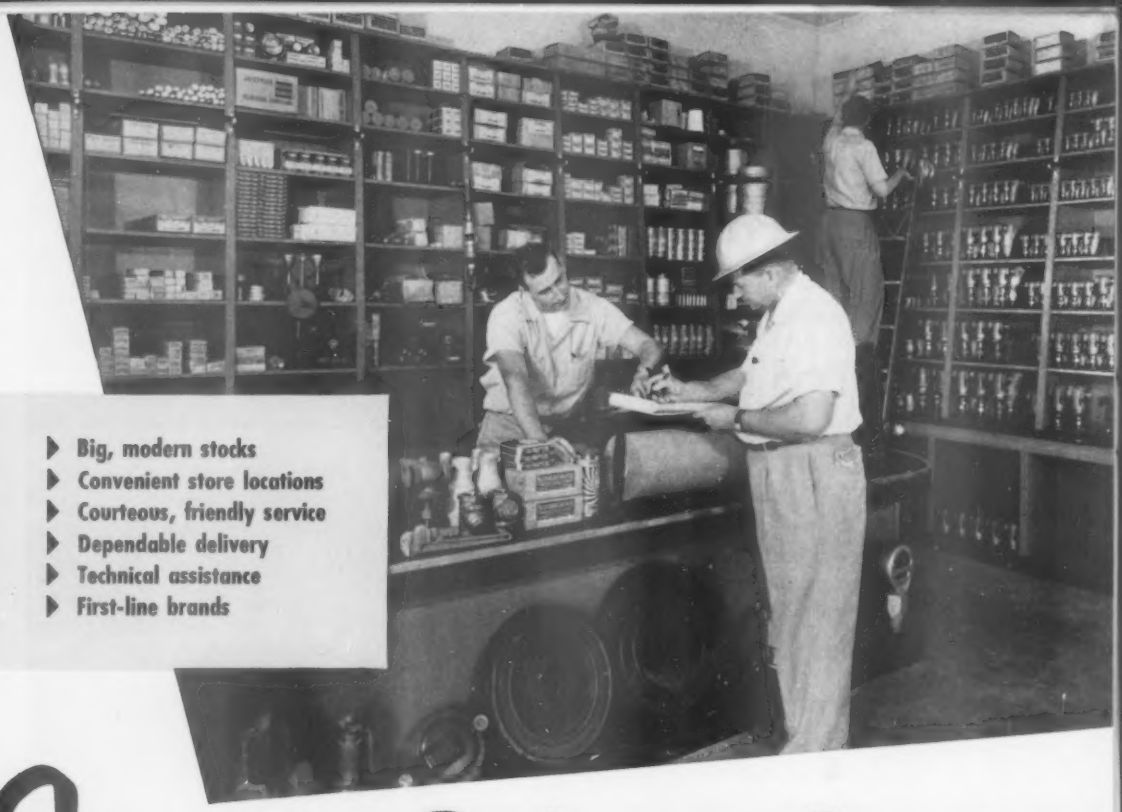

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# Six-point Refinery Service

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You'll find many pleasant reasons for doing business with Bethlehem. So, remember that yellow-and-black store that's located so near you. It means the place where your dollar buys a full hundred cents' worth.

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lution by its foaming action. Retarding agents are sometimes added when it is found that otherwise the reaction with the scale or deposit is too fast. Sustaining agents are added to increase the solubilities of dissolved solids, to prevent reprecipitating as the reaction proceeds.

Wetting agents are used to insure intimate contact of the cleaning solvent with the metal surface. A primary requisite for these materials is that the agents must remain active during the reaction and after the solvent is spent. Otherwise, the cleaning job may not be complete.

Reaction intensifiers are used to accelerate the cleaning reaction. These materials are catalysts, picked for specific reactions.

**Additives important . . .** The importance of these various additives cannot be stressed too much. For example, in one case involving the removal of oil-soaked scale, the reaction was completed in 5 minutes using solvent with an appropriate wetting agent. Tests on the same scale using identical solvent, except that the wetting agent was omitted, showed that only 30 per cent of the reaction was completed in 30 minutes, and that reaction rate at that time was practically nil.

**Use of other acids . . .** Other acids, such as nitric and sulfuric, may be used in chemical cleaning. Nitric acid is relatively expensive, difficult to inhibit, dangerous to handle in that it causes serious burns, and has few known additive agents. Sulfuric acid, while economical and easily inhibited, is dangerous to handle, has a large heat of dilution, and forms insoluble salts such as calcium sulfate.

However, there are a few specific uses for which these acids are recommended. These acids may be obtained in commercial quantities at 52 wt. per cent concentration for the nitric acid and 77 to 98 per cent concentration for the sulfuric acid.

Hydrofluoric acid is sometimes used to remove silicate scale. Because of the difficulties of handling this acid, fluoride salts are mixed with hydrochloric acid to form the required hydrofluoric acid, as previously indicated.

**Corrosion accelerated . . .** Certain constituents in the deposit or scale may accelerate the rate of metal corrosion by the solvent. Oxidizing agents, such as chromates, some copper compounds, manganese dioxide, and ferric iron compounds, tend to bring about this increase. Reducing agents also tend to nullify the effects of some inhibitors.

In some cases tests should be made to determine whether these effects are appreciable, and if so, precautions should be taken during the cleaning period.

A number of tests have been made to determine the extent of corrosion by electrolytic action between dissimilar metals in the same vessel during chemical cleaning. Results indicate there is no cause for concern, since the contact time is comparatively short.

**For organic deposits,** organic solvents, chlorinated organic solvents, and alkaline solutions may be indicated.

**Type of metal important . . .** In addition to the reactions of the scale, the type of metal in the equipment to be cleaned has an important bearing on solvent selection.

**Carbon steels** offer good resistance to inhibited acids at comparatively high temperatures. Small changes in composition of the steel may, however, change the corrosion characteristics considerably.

**Cast iron** may be cleaned with inhibited acid, but lower temperatures than those used for carbon steels should be employed.

**Stainless steels** are usually more resistant to corrosion than carbon steels, and inhibited acids may in general be used more freely. Chromium-nickel alloys are especially resistant. There are

**It's a TRANSITE PIPE salt water disposal line!**

Corrosion meets its match when you specify Transite* Pipe for your salt water disposal lines. Under corrosive conditions so severe that other pipe materials have failed in months, this modern pipe has provided years of dependable service.

There are two good reasons for this: First, Transite Pipe is made of asbestos, cement and silica—all corrosion resistant materials. Secondly, it is steam-cured for durability. The result is a pipe that is remarkably resistant to corrosive action of salt water on the inside, corrosive soil on the outside.

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**TRANSITE PRESSURE PIPE**

# THEY LICKED A TOUGH PROBLEM

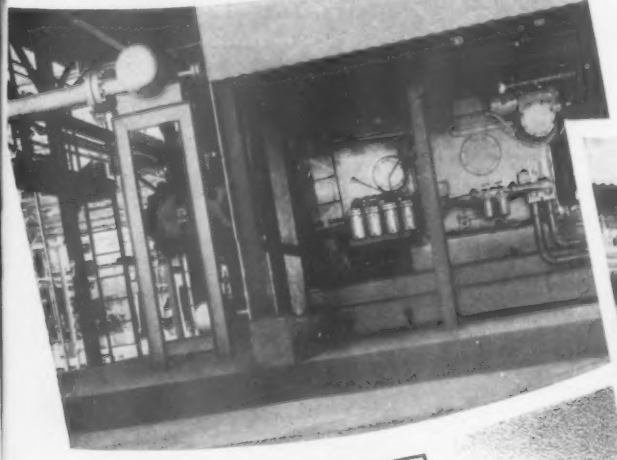
## *with Cooper-Bessemer*

THE two GMV's shown here operate as recycle hydrogen compressors for the remarkable new Platforming and Udex units in the Houston refinery of Eastern States Petroleum Company, Inc.

In this processing it was particularly important to avoid contamination of the recycle gas. To solve this problem, Cooper-Bessemer successfully developed ***non-lubricated compressor cylinders*** with light carbon pistons and segmented carbon rings. Moreover, cylinder bores were honed to a mirror finish of 4 to 6 micro inches. Now, after thousands of hours of operation, checks show no excessive wear anywhere.

If you have a similar problem, or compressor requirements of virtually *any* type, you'll find Cooper-Bessemer ready to cooperate . . . as usual . . . all the way.

End view of one of the GMV units showing method of separating engines and compressor cylinders.



As shown in this view, each 600 hp GMV drives 3 compressor cylinders, all of special non-lubricated design to avoid gas contamination. Eastern States' Platforming and Udex units, for which these GMV's handle recycle hydrogen, were put on stream early in '52 by Universal Oil Products Company.

ANGLE

# Compressors

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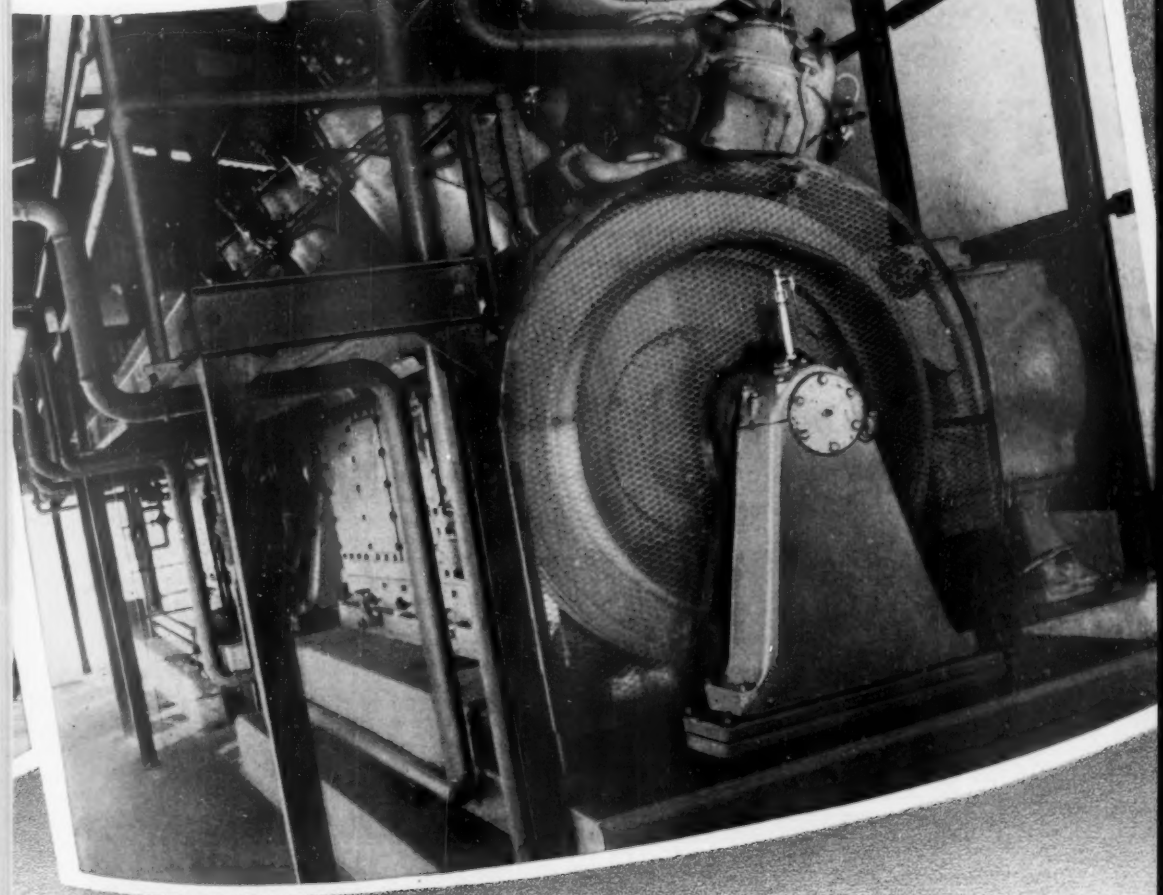
# *in Eastern States' Platforming Unit*

# GMV's

*Another Example of Efficient Power at Lower Cost*

Two 6-cylinder, 600 hp, Cooper-Bessemer GMV hydrogen compressors serving in Eastern States' Platforming and Udex operations. Compressor cylinders, on opposite side of safety wall at right, are not visible in this view.



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differences of opinion on the use of hydrochloric acid to clean any type of stainless steel, due to embrittling characteristics. However, there have been a number of instances where successful cleaning procedures using HCl have been employed on some types of stainless steel.

Inhibited acid should not be used on chromium stainless steels (little or no nickel) unless advance tests to determine corrosion characteristics are made.

**Copper and its alloys** may be cleaned with nonoxidizing acids.

**Nickel and its alloys** may be cleaned with nonoxidizing acids.

**Aluminum and its alloys** may be cleaned with mild alkalies and strongly oxidizing acids. Inhibited acid or strong alkali may not be used.

**Galvanized iron** should not ordinarily be cleaned by strong alkalies or inhibited acid, since the zinc coating will be removed.

Unless otherwise noted, all these metals may be cleaned with alkalies. All may be cleaned with organic solvents.

### Solvent Application

Motorized units are generally adapted for chemical cleaning of refinery equipment. These units are equipped with large metal tanks for transporting and mixing the required chemicals. Water and steam lines are run to the truck for diluting the chemicals to the desired concentration and heating the prepared solvent to the desired treating temperature.

Each unit has proportioning apparatus for metering and mixing the chemicals and pumping equipment for transferring the prepared solutions into the equipment to be cleaned.

**Equipment out of service . . .** Ordinarily, the equipment to be cleaned is taken out of service, drained, and isolated from the rest of the unit. Solvent is then pumped in through one of the lower connections, as shown in Fig. 1, until the vessel is full. Solvent is then allowed to remain in the vessel until it is clean. During this interval, the solution may be circulated continuously or intermittently, or may be allowed to stand without circulation.

When large amounts of iron or copper scale are present, the vessel is usually given a single-pass treatment. The solvent is not recirculated. However, as a general rule, equipment containing brass, admiralty metal, bronze, or other copper alloys, may be cleaned by solvent circulation.

Samples of the solvent are taken during the progress of the treatment. Analysis of these samples indicate the degree of completion of the reaction. When no change in solvent concentration is recorded between successive samples, the reaction is considered to be complete.

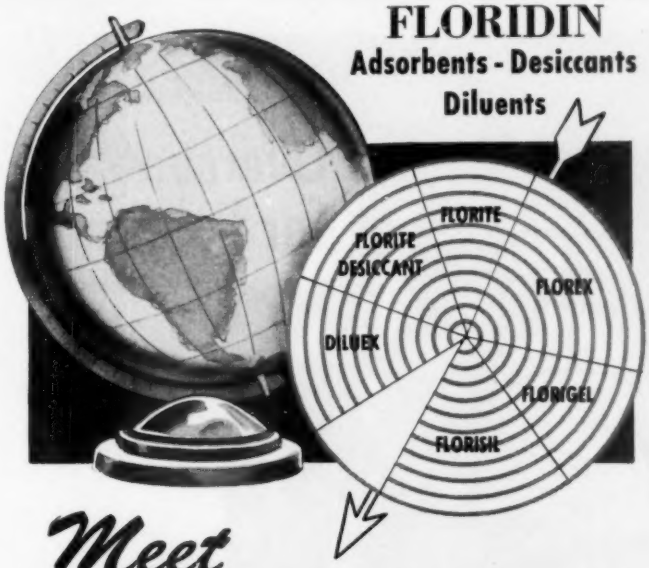
It is not necessary for the solvent to dissolve all of the material in the deposit. In most cases after some of the deposit is in solution, most of the undissolved scale will slough away from the metal surface. It can then be washed out, and the cleaning procedure will be successful.

After completion of the treatment, the solvent is drained from the vessel and disposed of. The equipment is then flushed thoroughly with water. An additional neutralizing flush is used to remove loosely adhering scale and any last traces of the solvent.

**Duplicate units . . .** In some instances it may be desired to provide duplicate processing units to prevent shutdown while the cleaning is in progress. This would be feasible, for example, when a heat exchanger is in service under conditions causing rapid deposition of scale or deposits.

When operating under this scheme, one exchanger is used until its operating characteristics indicate cleaning is necessary. This exchanger is removed from service and the second one is brought on stream. Cleaning of the idle exchanger then proceeds without shutdown.

In some cases, equipment can be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cleaned in operation. For example, as shown later, the water side of some exchangers and condensers can be cleaned without any curtailment in operation.

**Safety precautions . . .** Explosions have occurred during chemical cleaning when proper precautions were not taken. When hydrochloric acid reacts with iron, hydrogen is evolved. This reaction is of course suppressed by the presence of inhibitors in the acid, but it cannot be stopped altogether.

If this evolved hydrogen mixes with air in a confined space, any spark or flame can ignite the mixture and cause an explosion. One of the first precautions to be taken in chemical cleaning is the provision of adequate vent lines for the removal of hydrogen or other evolved gas.

In addition to hydrogen, hydrogen sulfide and sulfur dioxide are sometimes generated in chemical cleaning work. Hydrogen sulfide is evolved by action of hydrochloric acid on metal sulfides, while sulfur dioxide is produced from sulfites. Gas-detecting instruments, gas masks, and respirators should be provided for areas in which these gases may be evolved.

Hydrogen sulfide is extremely poisonous. It is lethal in concentrations of 25 to 30 p.p.m. in air. Consequently, all possible precautions should be taken to prevent the escape of this material. The area should be evacuated if leakage is detected.

Sulfur dioxide, while not so deadly, has a sharp, acrid odor, and is extremely irritating to the eyes, throat, and respiratory organs.

During most stages of chemical cleaning in a refinery, all flames should be prohibited. "No Smoking" and "No Welding" signs should be posted throughout the area.

Personnel handling acids, alkalies, some inhibitors, and some organic solvents should be provided with safety clothing. Rubber gloves and goggles are "musts" at all times, and rubber aprons, rubber hats, and rubber suits may be necessary.

### Case Histories

The chemical-cleaning problems encountered in petroleum refineries are quite varied. These examples, taken from Dowell Incorporated's, industrial bulletins, are typical of those that might be found in refining operations in any section of the country.

**Exchanger mixed deposit . . .** A heat exchanger processing desalted Illinois crude oil on the tube side operates at inlet temperature of 275° F. and outlet temperature of 320° F. When the heat-transfer surface became fouled, laboratory tests were conducted on a sample of the deposit. These tests showed it to be mixed inorganic-organic material. Analysis showed:

| | Per cent of total scale |
|---|---|
| Inorganic matter, HCl-soluble | 49 |
| Inorganic matter, HCl-insoluble | 12 |
| Organic matter, $CCl_4$-soluble | 31 |
| Organic matter, $CCl_4$-insoluble | 8 |
| Total soluble | 80 |

The solvent chosen for this job was an emulsified solution, containing both inhibited hydrochloric acid and a carbon tetrachloride-based organic solvent. Two batches of this solution were used in circulation treatment. The unit was then flushed, neutralized, and put back into service. Operating results showed the cleaning to have been completely satisfactory.

In another heat exchanger, following this one, outlet temperature of the oil is over 400° F. When this exchanger became fouled, tests were made which showed total material soluble in HCl and $CCl_4$ was only 47 per cent, as compared with 80 per cent on the previous exchanger. Attempts to clean this exchanger with the mixed emulsified solvent were unsuccessful.

**Noncirculating exchanger treatment . . .** Conventional treatment methods have proved satisfactory in cleaning a heat

A Shell Photograph

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*The photograph shows a column at Shell Chemical Plant, Stanlow, Cheshire, England.*

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exchanger in the toluene section of a large refinery. Circulation of the solvent caused severe corrosion, due to the presence of iron chloride in the circulated solution. In addition, the scale (primarily red iron oxide) was not satisfactorily removed.

The piping arrangement shown in Fig. 2 has been used to eliminate these difficulties. Acid solvent was pumped into the shell side at 160° F. and allowed to soak for 7½ hours. Temperature was maintained by circulating hot water through the tube side of the exchanger. The solvent was agitated from time to time during the soaking period by bubbling carbon dioxide through the inlet nozzle on the bottom of the shell.

After the soaking period, the solvent was drained, and the unit was reverse flushed with water. Final treatment was made with 2 per cent phosphoric acid solution, maintained in the unit at 210° F. for 10 hours.

Inspection showed the exchanger to be substantially 100 per cent clean.

**Condensers, tube side . . .** Two condensers in a gas-absorption plant have been cleaned without shutdown. The units consist of two two-pass condensers in series. Condenser shell is of low-carbon steel, while tubes are of admiralty metal. The units are used as coolers on overhead from a rich-oil still. Normal temperature of product effluent is 85° to 90° F., but fouling of the tube side with calcium carbonate deposit had raised this to 98° to 102° F. As a result, a considerable amount of gasoline was being lost.

Two hoses were connected from the chemical truck to two connections on the water inlets to the condensers. Water was entering the condensers at a rate of 1,500 g.p.m. Concentrated acid solution was pumped into the water stream at 100 g.p.m.

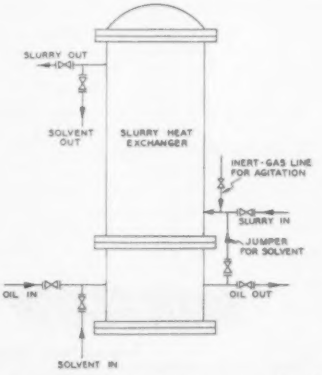
After pumping 1,300 gal. of solvent into the condensers, product effluent temperature had dropped from 98° to 90° F. Another 850 gal. of the solvent was pumped into the condenser, with further drop in product effluent temperature to 88° F.

The solvent leaving the unit had a pH of approximately 1.8. This was raised to above 7 with caustic soda before it entered the cooling tower.

Cost of this job was $953.50, as compared to approximately $225.00, had the units been out of service. However, since a shutdown was avoided, the cleaning job paid for itself in less than a week.

**Slurry exchangers, process side . . .** Slurry exchangers are vertical tube-and-shell bundles used in the fluid cat cracking process. Unit charge stock passes through the tube side of the bundle on its way to the catalyst bed. Slurry (heavy ends and catalyst fines coming off the fractionating column) passes through the shell side, giving up part of its heat to the charge.

The shell side of the exchanger becomes heavily scaled with a deposit consisting essentially of organic materials, iron oxide, and iron sulfide. A conventional fill-and-soak chemical




**SLURRY EXCHANGER on cat cracker is cleaned by pumping solvent through shell and tubes in series. Fig. 3.**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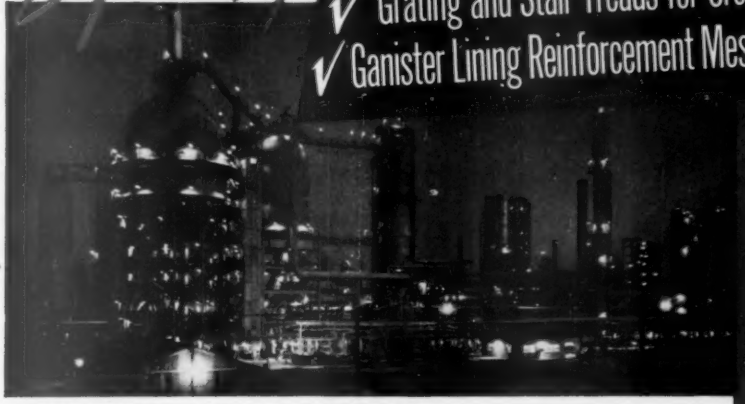

(Above) Thousands of square feet of KLEMP HEXTEEL installed in World's Biggest Catalytic Cracker Unit at this Giant Gulf Oil Refinery in Port Arthur, Texas.

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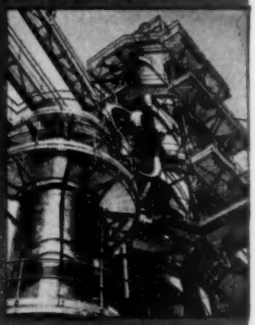
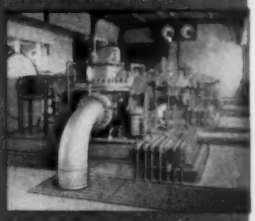


(Below) NEW KLEMP KREST* WELDED GRATINGS are made from special steel bars so formed to provide a peak or krest on the top side of the bar which gives this type of grating maximum non-slip characteristics. Ideal for structural foot walks as well as all other universal uses.



(Above) GANISTER LINING REINFORCED with KLEMP HEXTEEL (shown being welded into a cat cracker) keeps CATALYST REGENERATORS ON LINE Longer. HEXTEEL, when applied, as a reinforcement mesh is filled with a cement filler. This reduces "turnarounds" to a minimum and helps avoid scouring and abrasive actions of the catalyst which can quickly ruin cat crackers and thermal crackers.

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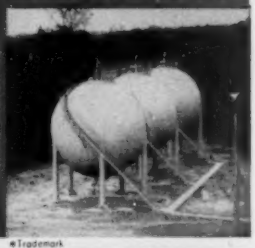
(Below) Klemp Manufactures Diamond Riveted, Welded and Serrated Stair Treads. This Serrated Tread has been developed especially for installations where unusual precautions are necessary to avoid accidents resulting from grease, mud, snow, etc.



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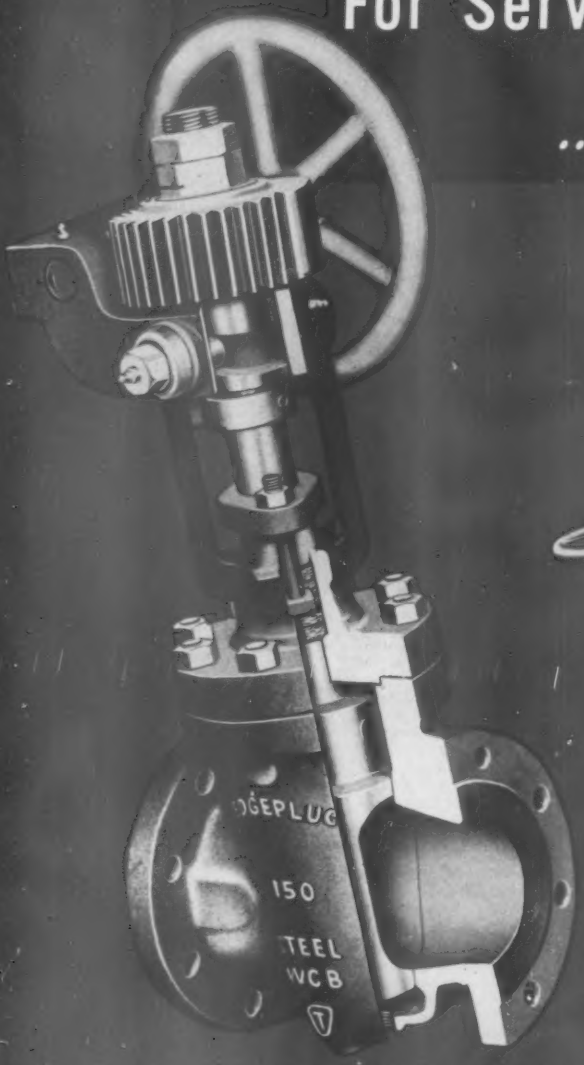


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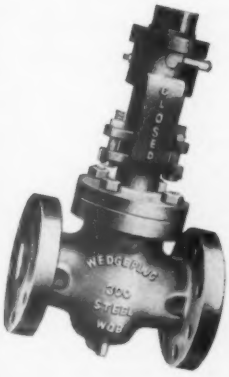


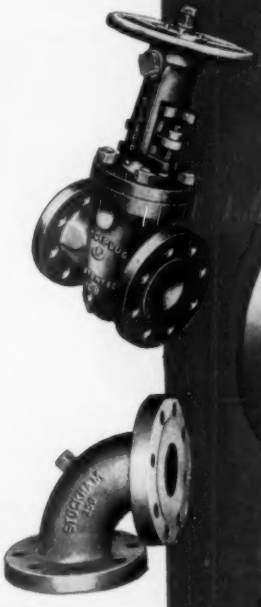


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**STOCKHAM VALVES AND FITTINGS**

treatment will not do a thorough job of cleaning these units.

In a cleaning job recently performed on a slurry exchanger, the bundles were pulled and degreased with steam lances, and scale was sawed from between the tubes. The bundles were then placed back into the shells and both tube and shell sides were cleaned in place with acid solvent at 165° F. Solvent was discharged into a drum and recirculated periodically. Shell and tube sides were cleaned in series, as shown in Fig. 3. After a 6½-hour soaking period, the solvent was drained, and the units were flushed with water. Results were as follows:

| | Before | After | Design |
|---|---|---|---|
| U, B.t.u./hr./sq. ft./°F. | 18 | 60 | 60 |

In another instance, two slurry exchangers were cleaned on the shell side only. Light gas oil at a temperature of 400° F. was piped off the unit fractionating tower, through the shell side of the exchangers, and back to the bottom of the tower for recovery.

Following this a mixture of organic solvent and gas oil was circulated through the shell for 2 hours at 200° F., to remove the grease. An acid solvent was then used for 6 hours at 150° F. The solvent was agitated intermittently by an inert gas bubbled through one of the exchangers. Before and after results were:

| | Before | After | Design |
|---|---|---|---|
| U, B.t.u./hr./sq. ft./°F. | 30 | 50 | 60 |


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**Bubble-cap towers . . .** A bubble-cap tower in a Mid-Continent refinery had considerable amounts of scale on the trays and caps. The scale consisted largely of iron oxides, approximately ⅛ in. thick, containing quite a bit of oil.

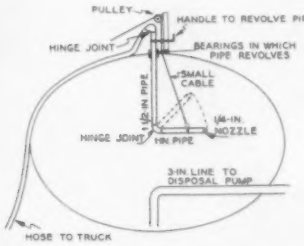
After the tower had been drained of process fluids, it was first degreased with an alkaline-base solvent at 170° F. for 4 hours. After thorough flushing, acid solvent was added at 160° F. and allowed to remain in the tower for 8 hours. The tower was then drained, filled and emptied twice with water, and then washed from the top down for 4 hours.

To prevent sloughed scale from settling on the traps and bubble caps, large volumes of air were introduced in the bottom of the tower during the final water wash. Agitation of the water by the gas kept the scale in suspension, and the mixture was drawn from the tower.

No appreciable amount of scale remained on the trays and caps in the tower.

**Spheroid-tank cleaning . . .** Two 840,000-gal. spheroids, used for storing liquid propane, accumulated a thin scale consisting of iron oxide and iron sulfide on the inside surfaces.

Acid solvent was applied to the upper half of each tank by means of the spray gun shown in Fig. 4. The upright




**SPRAY GUN is used to clean the inside of tanks. Fig. 4.**

section of pipe used in the gun was suspended on a ball-bearing support at the top of the tank. This section extended into the tank a distance equal to about one-third of the total height. A side-arm pipe 8 ft. long was attached to the end of the upright pipe, using a hinge joint. The other end of this pipe was fashioned into a nozzle. A cable was attached to the side arm and run through pulleys so the assembly could be raised or lowered.

Acid solvent was pumped through the spray gun at 130° to 140° F. The gun was first directed at the top, then gradually lowered until the jet was striking the center of the tank. At each

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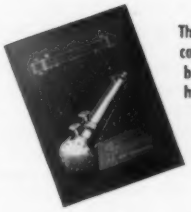

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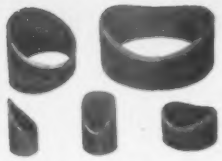

SPEED PIPE FABRICATION WORK with the

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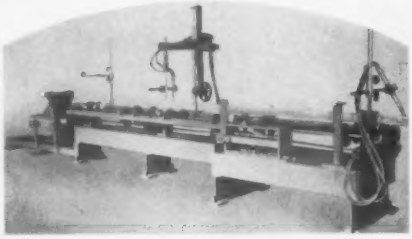

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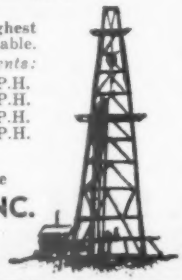

THE GORMAN-RUPP COMPANY
MANSFIELD, OHIO

level the gun was slowly rotated through 360°. From the center line of the tank, the solvent ran down over the entire bottom half, making it unnecessary to further lower the gun. Each tank was given two treatments, one of approximately 5,000 gal. and the second of 1,500 gal. Total time of treatments was about 12 hours.

Disposal of the solvent was accomplished in pumping it to waste from the bottom of the tank. Because of its high iron content, the solvent was not recirculated.

The scale was satisfactorily removed by this treatment.

**Gasoline-tank cleaning . . .** Five 6,000-bbl. gasoline-storage tanks have been cleaned using thickened acid. The oval-roofed tanks, 40 ft. in diameter by 37 ft. high, had a rust film on the inside surfaces, requiring removal prior to their being converted to bright-stock storage.

The cleaning procedure consisted of spraying the tank walls, floor and internal steam coils with thickened acid solution, flushing it off with water, spraying the surfaces with weak soda ash solution, drying the surfaces by turning steam into the steam coils, and spraying the dry surface with a light oil to prevent rusting.

The thickened acid was pumped at 1,500 psi. through a 12-ft. lance equipped with a T-shaped spray nozzle. Approximately 20 minutes was required to cover all the internal surfaces in the tank. The acid was allowed to stand 12 to 14 hours before water flushing. Approximately 450 gal. of thickened acid was used per tank. An air ejector was mounted on the top of each tank to remove acid fumes. No gas masks were required.

Two men remained inside the tank during the spraying operation. Portable telephones were used to maintain communication with the equipment operator outside.

Water flushing was done at 2,000 psi., using the lance. About 2 hours was required for this operation. At the end of that time, the metal surfaces were completely free of rust and scale. After the surfaces had been dried, each tank was sprayed with oil during a 15-minute period.

**Refinery line cleaning . . .** Four thousand feet of 24-in. main lines and twelve 100-ft. sections of 24-in. laterals have been cleaned using the Dowell combination chemical-mechanical pipeline pig in the main lines and the Dowell jet mole in the laterals. These pieces of equipment are shown in Figs. 5 and 6.

The lines had been used for han-

# Fully Crowned Tooth Design Can Be Used To Solve Your Long-Standing Coupling Problem

A major improvement in gearing for power transmission—a fundamental improvement in gear tooth design that practically eliminates all "end tooth and tip" contact and provides greater freedom of axial movement distinguishes Amerigear Couplings from common gear-type couplings. Amerigear Couplings offer many more advantages than are obtainable with the common basic designs. The Amerigear Crowned Tooth Design can be applied wherever couplings are required. There are many instances where this design has been utilized to simplify power transmission mechanisms and add reliability to their performance in a measure heretofore found impossible.

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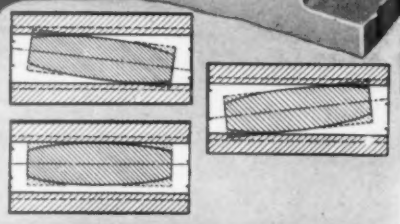

Comparison Of Amerigear Fully Crowned Tooth Design With Gearing Of Conventional Gear-Type Couplings Shows How "End Tooth And Tip" Contact Is Practically Eliminated And Why Greater Freedom Of Axial Movement Is Provided By Amerigear Fully Crowned Tooth Design (dotted lines indicate gear teeth of conventional gear-type coupling).

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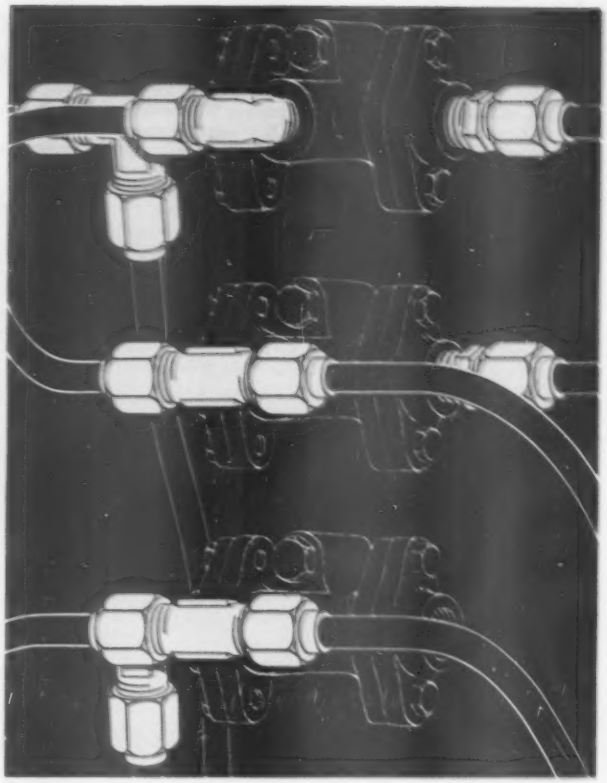
## ON DIESEL ENGINES

This typical Diesel engine manufactured by The National Supply Company, Engine Division, Springfield, Ohio, is equipped with Parker Triple-lok Fittings.



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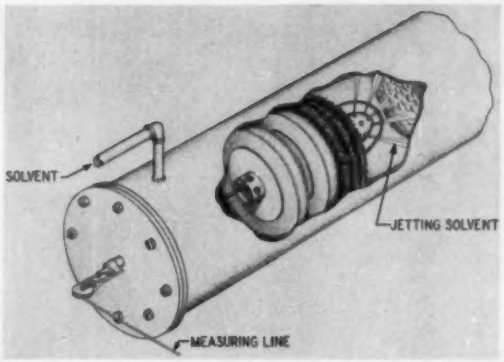
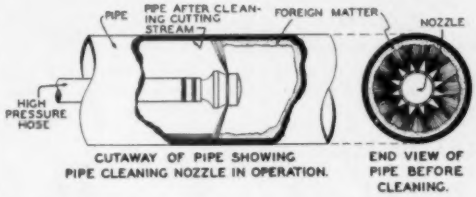
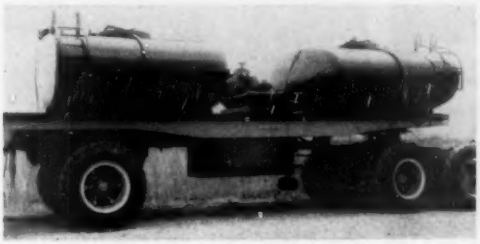
**PIPE-LINE PIG** accomplishes cleaning by a combination of chemical and mechanical means. Fig. 5.




**JET MOLE** is also used to clean pipe by a combination of chemical and mechanical means. Fig. 6.



**TRAILER-MOUNTED** cleaning unit contains two tanks plus necessary pumps and piping.

dling crude oil, and a heavy, greasy wax deposit had accumulated in them. This deposit had to be removed, since the lines were to be put in kerosine service.

Pumps were used to push the pig through the main lines. Water and kerosine were pumped alternately into these lines to dissolve the deposit. Satisfactory cleaning was accomplished after one pass through each line with the pig.

The lateral lines were also cleaned with kerosine and water, using the jet mole to get the deposits into solution. Some of the lines were jetted three or four times to insure proper cleaning, since they were only partially filled with fluid.

Total pumping time for the operation amounted to 6 hours. A total of 6,806 gal. of kerosine was used on the job. The cleaning operation was pronounced satisfactory in every respect.

### Other Articles on Chemical Cleaning


C. M. Loucks and C. H. Groom, "Chemical Cleaning of Heat-Exchanger Equipment," Transactions of the A.S.M.E., October 1949.

"A.S.T.M. Symposium on the Identification of Water-Formed Deposits, Scales, and Corrosion Products by Physical Chemical Methods," Proceedings of A.S.T.M., Vol. 43, 1943, pp. 1269-1310.

W. L. Lee, "Chemical Removal of Scale from Refinery Equipment," Petroleum Refiner, June 1950.

"Chemical Removal of Scale as a Factor in Speeding Production," The Oil and Gas Journal, May 20, 1943.

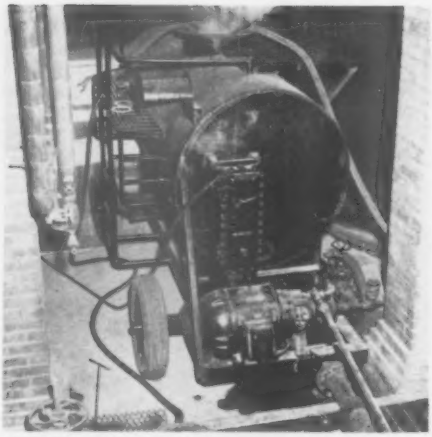
C. H. Groom, "Chemical Cleaning of Process-Side Equipment," Petroleum Engineer, May 1950.

F. N. Alquist, C. H. Groom, and G. F. Williams, "Chemical Removal of Scale from Heat-Exchange Equipment," Transactions of the A.S.T.M., October 1943.

E. W. Feller and G. F. Williams, "Chemical Cleaning Takes the Bull Work out of Scale Removal," Power, September and October 1946.

W. M. Zingg and B. P. Robinson, "How to Clean Slurry Exchangers," Petroleum Processing, June 1952.

R. Tunnel and J. T. Browning, "Chemical Removal of Scale from Water Lines," Southern Power and Industry, November 1947.



TYPICAL PORTABLE cleaning wagon in use in the Ponca City refinery. Units such as this are used for most chemical cleaning jobs.

SMALL PORTABLE cleaning wagons are available for chemical cleaning of small units, or where working space is limited.

CONTINENTAL CLEANS IN-PLACE

# Chemical Cleaning Is a Versatile Tool

by T. N. Griswold* and J. O. Thoen†

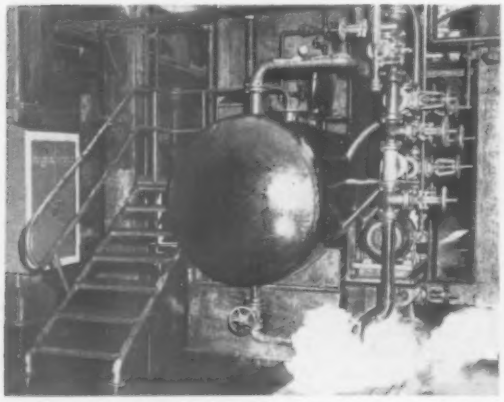
When the chemical cleaning method is applicable, it is efficient, time saving, and economical. Advantages are:

1. Outage time is greatly reduced.
2. Major dismantling of equipment is unnecessary, since the solvents circulate through the entire system, penetrating wherever the process fluids flow. Scale usually is completely removed.
3. Extra labor and equipment are kept to the minimum.
4. Replacement of equipment is minimized.
5. Equipment may be designed for utility and efficiency, rather than for accessibility.
6. Metal loss is inconsequential.

IN-PLACE cleaning with chemicals is used successfully on a variety of equipment at the Ponca City, Okla., refinery of Continental Oil Co.

Several different types of cleaning equipment have been adapted for this work. Two sizes of trailer-mounted tanks, including pumps and mixing facilities, are in use where portable units are required. A permanent in-

*Metallurgist, manufacturing department, and †chief maintenance engineer, manufacturing department, Continental Oil Co., Ponca City, Okla.



PERMANENT HOOKUP pictured here is used for chemical cleaning of critical heat-exchanger bundles on two light-oils units.

FLANGES, NIPPLES, AND VALVES are chemically cleaned at the refinery's salvage yard before reissue.

# REFINERY PROCESS NEWS

PUBLISHED BY REFINERY PROCESS DIVISION, THE M. W. KELLOGG COMPANY MARCH 1953

## New Sulfur Removal Process Promises Maximum Oil Yield

Because of the increasing volume of high sulfur crudes being produced, many refiners have shown considerable interest in the new desulfurization process—Autofining—which has been developed and commercially tested by the Anglo-Iranian Oil Company, Ltd.

The process has particular significance for those refiners who are running crudes from West Texas, the Middle East, West Coast and South America and who are finding it virtually impossible to meet sulfur specifications for No. 2 heating oil.

Moreover, the production of jet fuels will present many refiners with major desulfurization problems as use of this type of engine spreads. It also naturally affects all products from kerosene on down.

The Autofining process—licensed on a world-wide basis by Kellogg—has several advantages over conventional acid treating. Its most important superiority rests in the yield factor. Autofining assures yields of 98% or better on practically any virgin gas oil. This in comparison with yields which may be as low as 88 to 90% on the same stock run through acid treating equipment!

Though the initial investment is high for Autofining in comparison with acid treating, operating costs are so drastically lowered that savings in this category alone can pay out an Autofining plant in from two to three years. Beyond this are the obvious advantages of eliminating acid handling and disposal.

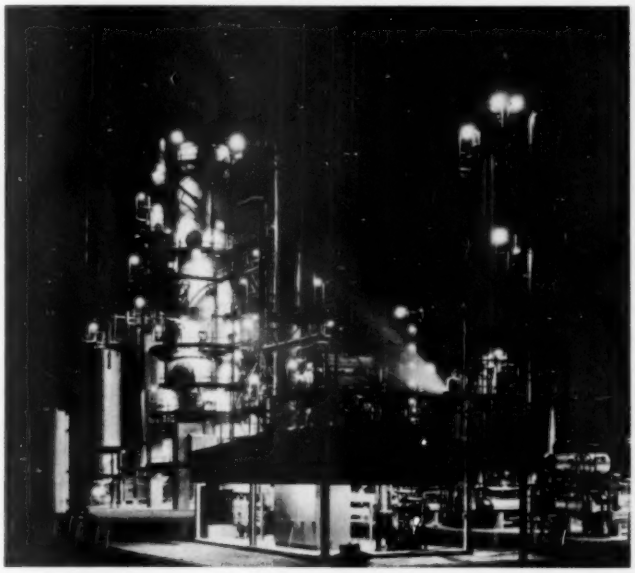
To summarize, the Autofining process offers immediate, major benefits to refiners where the need for effective desulfurization is current. And while

*(Continued on following page)*

**Approximate Utilities for 3500 BPSD Autofining Unit**

*Typical Kerosene Operation*

| ITEM | Reaction Period | Regeneration Period | Daily Average |
|---|---|---|---|
| Period, Days | 29 | 1 | |
| H. P. Steam 235# G., Gen. | 8000 | 0 | 7730 |
| H. P. Steam 150# G., #/Hr., Cons. | 6560 | 10,000 | 6674 |
| Cooling Water, G. P. H. | 36,000 | 0 | 34,800 |
| B. F. W., G. P. H. | 840 | 0 | 812 |
| Fuel MM, Btu./Hr. | 25 | 3.1 | 24.3 |
| Power, KW. | 20 | 20 | 20 |
| Air SCF/Hr. | | (15,000) | |
| Caustic—100% NaOH, #/Day | 46 | | 46 |
| Sulfur Reduction | 0.4 Wt. % | to 0.1 Wt. % | |



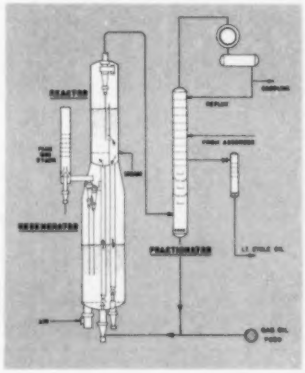
## Major Refinery Modernization Program Includes the Tenth ORTHOFLOW Cracker

Part of a recent contract with a Southwestern refiner, the tenth Orthoflow Fluid catalytic cracker is now being engineered and will soon be under construction.

The first cracking unit of this exclusive Kellogg design went on stream about two years ago in Canada. Two others are now in operation in the U. S. and the Dominion. Those, either operating or planned, range in size from approximately 2,500 to 28,000 BPD fresh feed. However, with recycle, the reactor throughput of the largest is increased to 44,000 BPD.

On the whole the first three Orthoflow crackers have operated successfully, producing good yields and high quality products. As with any process unit of novel design, some operational difficulties have been experienced. These have largely centered about catalyst loss, but recently completed studies—results of which will naturally be incorporated in existing units as well as those under construction—indicate that the catalyst loss problems can be solved without appreciable effect on the recognized low investment cost of the Orthoflow.

Unchanged are the basic design advantages of the units . . . the straight-line catalyst flow . . . the highly successful plug valves which "double" as absorbers of thermal expansion . . . the upright construction with its concomitant savings in foundation and structural steel costs.

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DECARBONIZING DESULFURIZATION

CONTINUED FROM PRECEDING PAGE



## Autofining . . . cont.

virtually all demands for jet fuel can be met easily today by processors with sufficient sweet crude, either of two situations arising in the future could throw this particular demand-supply picture out of balance:

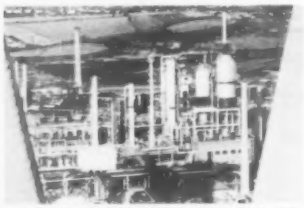
1) A war emergency requiring the majority of refiners to handle sour crudes just to meet the requirements of an "all out" Air Force, and

2) Rapid acceptance of jet propulsion by commercial airlines, coupled with continuing "cold war" demands.

AIOC has proved the process through several years of operation on 150 and 300 BPD semi-commercial units and is now operating a 3,500 BPD plant. Complete commercial processing data are available from this unit on a variety of stocks. (*Ask for a review of these data to evaluate the potential of Autofining in your processing sequence.*)

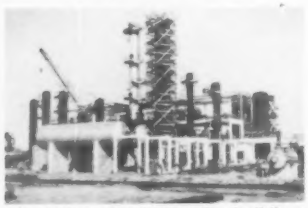
## ON KELLOGG JOB SITES...

*Shown below are just three of the more-than-a-score of job sites where Kellogg construction crews are erecting a variety of refinery and chemical plants in many parts of the World.*

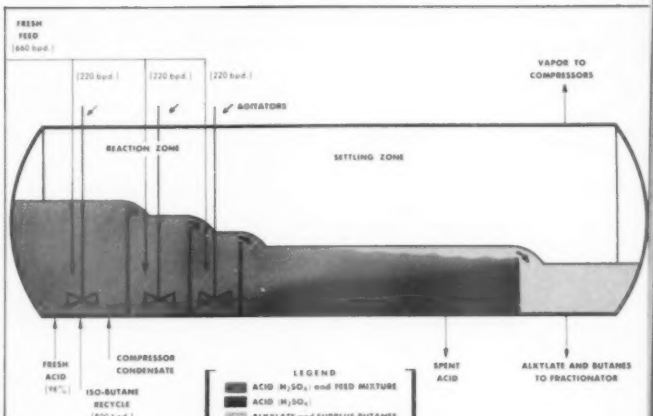


In England a Fluid catalytic cracker of the familiar side-by-side type has just been completed.

Work is progressing rapidly on a complete lubricating oil plant in the Southwest.

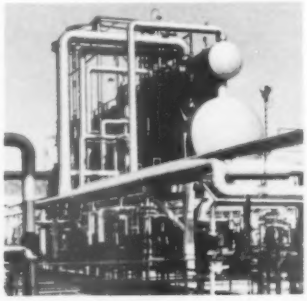


An alkylation plant, incorporating the Kellogg cascade reactor, takes shape in South America.




## Cascade Reactor, Recently Introduced, Is Highly Successful in Alkylation Plants

While the intrinsic value—forgetting for the moment the expressed desire of the Government for increased avgas production—of alkylation in today's or tomorrow's refinery is a moot point with many refiners, it is a fact that, since the first units were rushed on stream during World War II, the process has undergone several major design improvements which have improved its economics.



For example, two years ago Kellogg brought out its new cascade reactor for sulfuric acid alkylation. Peculiar only to Kellogg designs, this reactor provides a most desirable high ratio of iso-butane to butylene without the additional expense of extensive iso-butane recycling equipment required in conventional plants. In addition, the overall plant design maintains acid consumption at the lowest possible level and, through the use of auto-refrigeration, keeps the initial investment at a minimum.

Three of these new reactor designs have now been put into service. A fourth will be the heart of a contract for the design and erection of a new plant in a Rocky Mountain refinery. Experience with the novel reactors, which have undergone even further refinements since the first was installed two years ago, has shown exceptionally high yields of superior alkylate with concomitant savings in utilities and other operating costs.

***For further information, technical data, etc., on any refining process, write***

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stallation has been made for cleaning processing equipment at two light-oil units. Tanks, pumps, and piping are included in this setup.

Facilities are also available for cleaning valves, drums, pipe, and fittings by chemical means.

**Versatile tool . . .** Chemical cleaning can be adapted to almost all types of process equipment. Depending on the circumstances, towers, drums, lines, and all types of heat exchangers may be cleaned efficiently and economically by this method.

Time required for the cleaning procedure varies according to the amount of material to be removed and the type of scale or deposit encountered. As little as 2 hours is required in some instances, while as much as 24 hours is required in others.

After considerable experience with chemical cleaning, it is concluded that there is no appreciable danger of corrosion during the cleaning procedure, provided proper precautions are taken and the problem is studied thoroughly in advance. While there may be some metal loss due to in-place cleaning, this has not been significant.

### Cleaning Heat Exchangers

There are over 800 major heat exchangers in the Ponca City plant. The breakdown on application of these units is approximately as follows:

| | Per cent of total |
|---|---|
| Water-cooled exchangers (shell-and-tube) | 47 |
| Oil-to-oil exchangers (shell-and-tube) | 22 |
| Steam-heated reboilers and heaters | 17 |
| Steam-generating equipment | 2 |
| Steam condensers and jacket-water coolers | 3 |
| Open-top coolers | 9 |

**VALVE-CLEANING facilities at Ponca City plant include chemical cleaning vat and various high-pressure lances for jetting.**

**Water-cooled units . . .** Most maintenance is required on the water-cooled exchangers and condensers. About 75 per cent of these units require tube-side cleaning due to water scaling. Water scale consists principally of precipitated carbonates, deposited rust, and slime.

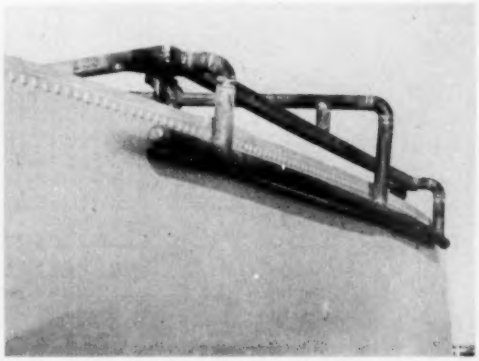
Of the water-cooled units which require tube-side cleaning, about 30 per cent are acid washed with inhibited hydrochloric acid on a regular schedule. The remainder are allowed to scale until the tubes have plugged appreciably, since heat transfer is reduced very little by this procedure. These units are at times cleaned chemically. Manual cleaning procedures are also used when it is found necessary to open the exchangers for inspection or repairs.

As more history is gathered on these units, they will be placed on the chemical-cleaning schedule, since chemical cleaning is more economical than manual methods.

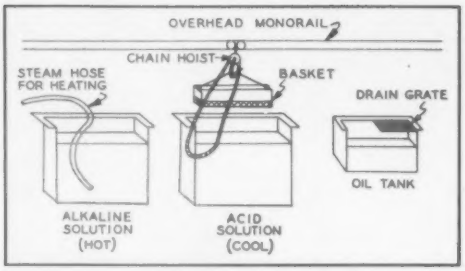
**Oil-to-oil exchangers . . .** About 20 per cent of the oil-to-oil exchangers are cleaned on the shell side with a commercial preparation consisting mostly of $NaHSO_4$ (sodium acid sulfate) and some detergent.

This solution is circulated through the shell with the tube bundles in place. Many bundles containing extensive deposits of black, oily tars are cleaned fast, efficiently, and economically in this manner Many more which presently are manually cleaned with scrapers, saws, hot-water hose blasts, etc., could be cleaned more economically with this solution.

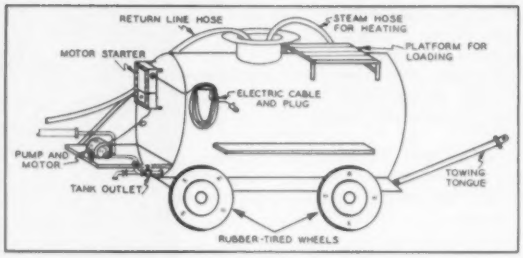
Another commercial preparation used in cleaning oil-to-oil exchangers is a mixture of caustic soda, silicates, soap, and resin. This solution, which



**TANK-STRIPPING APPARATUS is used to remove layers of old paint when repainting of a tank is scheduled. At left is shown the piping layout on top of the tank. At right are shown the various fittings used for cleaning the side of the tank.**




FITTINGS ARE CLEANED at the salvage yard. Successive alkaline, acid, and oil treatments are used in the process. Fig. 1.




REGULAR CLEANING WAGON details are shown in this sketch. Tank and motor are mounted on rubber-tired four-wheel trailer. Fig. 2.

is quite alkaline, is used to neutralize HCl-cleaned areas and to remove certain types of deposits.

Occasionally, a petroleum distillate containing an oil-soluble detergent is used for cleaning oil-fouled equipment. In general this procedure is used for deposits that are neither too hard nor too thick.

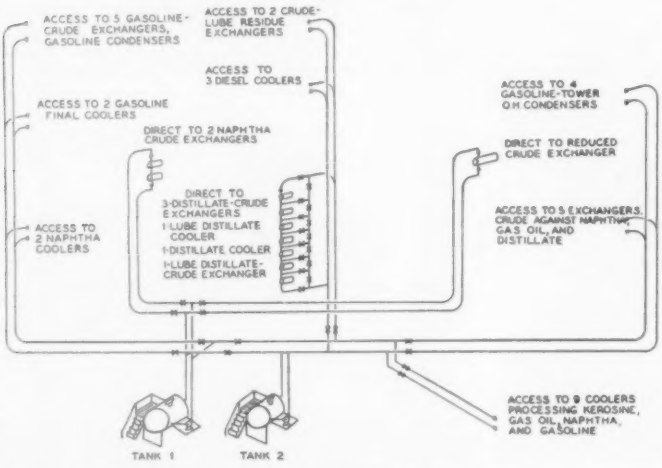
**Exchanger case histories . . .** Scale deposited in the water coolers at Ponca City is comparatively easily removed. Usual procedure is to fill the exchanger system with inhibited HCl at room temperature and to circulate the acid solution through the equipment for 4 hours. The solution is then drained and washed with water. Final neutralization is with a solution of soda ash, or as previously indicated.

At the end of this treatment, the channel cover plate is removed and the tubes inspected. Usually the cleaning is substantially 100 per cent effective. Tubes are given a final water wash while the plate is off.

An oily deposit is formed on the crude (shell) side of a crude-to-reduced-crude exchanger in the plant. When cleaning, the shell side of the exchanger is filled with $NaHSO_4$ solution which is circulated for 6 hours. Most of the deposit is removed by the solution. The remaining material is attached to the tubes quite loosely, and hosing with water effects removal.

Heat exchangers on the HF alkylation unit are often polluted with hydrofluoric acid.

In cleaning these units, the bundles are removed and placed in cleaning vats where the acid is neutralized with alkaline solution. After the neutralization process, these vats are used for soaking the bundles in various kinds of solvents for removal of the deposits. Final neutralization after deposit removal is carried out in the manner previously indicated.


ACCESS TO 5 GASOLINE-CRUDE EXCHANGERS, GASOLINE CONDENSERS
ACCESS TO 2 CRUDE-LUBE RESIDUE EXCHANGERS
ACCESS TO 3 DIESEL COOLERS
ACCESS TO 2 GASOLINE FINAL COOLERS
DIRECT TO 2 NAPHTHA CRUDE EXCHANGERS
DIRECT TO 3-DISTILLATE-CRUDE EXCHANGERS
1-LUBE DISTILLATE COOLER
1-DISTILLATE COOLER
1-LUBE DISTILLATE-CRUDE EXCHANGER
ACCESS TO 2 NAPHTHA COOLERS
ACCESS TO 4 GASOLINE-TOWER O.H. CONDENSERS
DIRECT TO REDUCED CRUDE EXCHANGER
ACCESS TO 5 EXCHANGERS, CRUDE AGAINST NAPHTHA, GAS OIL, AND DISTILLATE
ACCESS TO 9 COOLERS PROCESSING KEROSINE, GAS OIL, NAPHTHA, AND GASOLINE
TANK 1
TANK 2

PERMANENT CHEMICAL CLEANING hookup is used for two Ponca City units. Two tanks are connected to various coolers, condensers, and exchangers. Fig. 3.

These vats are also used for other bundles where long soaking time facilitates chemical cleaning.

### Cleaning Other Equipment

While most chemical cleaning is done on heat exchangers, other processing units are also cleaned by these methods. Distillation towers in particular lend themselves to this treatment.

**Tower-cleaning procedure . . .** General procedure for cleaning this equipment is to block off all openings except the top reflux and either side drawoff or tower bottom. The tower is then filled with the proper cleaning solution. The solution is heated to the proper temperature by admitting steam to the bottom of the tower. The steam serves to agitate as well as heat the solution.

After the solution has reached the proper temperature, it is circulated through the tower for a predetermined time period. A typical cleaning time is 24 hours. Makeup chemical solution is added from time to time since the original solution loses strength as cleaning progresses. Final neutralization is similar to that used for heat exchangers.

Some refinery units can be chemically cleaned when there is no other practical method available. One such case occurred in the operation of an alkylation stripper tower on the alkylation unit. The tower, which is packed with aluminum Raschig rings, became plugged to the extent that operations were curtailed. Manual cleaning would have entailed a long, expensive shutdown and a number of unusual procedures.

During shutdowns these rings are removed and chemically cleaned in vats of hot solution, the only practical method available. Manual cleaning is not feasible.

**Tank cleaning and stripping . . .** When

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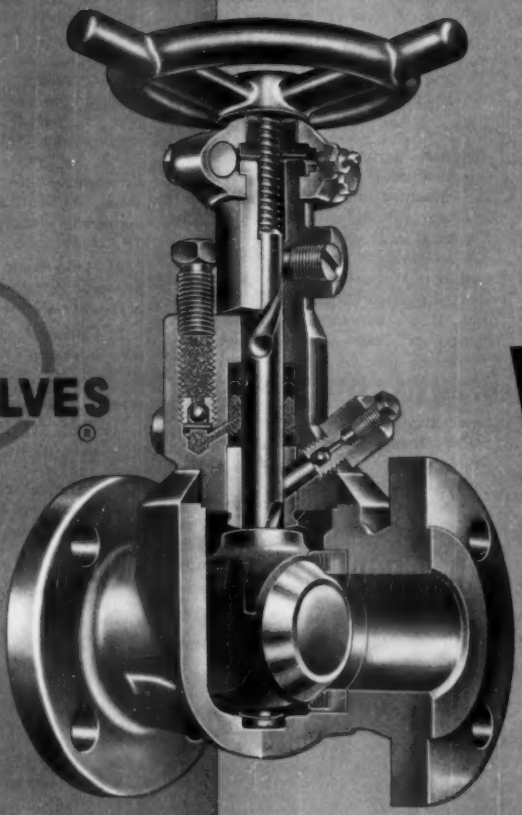

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storage tanks are switched from one service to another, it is often necessary that they be cleaned. The procedure followed in this case is to spray the inside area, (side, top, and bottom), with appropriate solution until scale, rust, or deposit is removed.

The tank-cleaning apparatus consists of a three-wheeled frame, which sits on the floor of the tank; an upright pipe; and a nozzled header attached to the pipe. The spray header is raised or lowered by a hand-crank-driven winch. The header is connected by hose to the chemical wagon outside the tank.

Tank stripping is necessary before repainting a tank which has heavy layers of paint or which is peeling. This is also necessary when considerable welding must be done, such as in sealing leaks by welding old tanks which are leaking.

The tank-stripping equipment is detailed in two accompanying photographs. This device is connected to the chemical wagon by means of rubber hose, and chemical solution is sprayed against the side of the tank at the top.

The labor involved is primarily that of piping and rigging before and after stripping. Two men can do the stripping job on one tank during one 8-hour shift.

**Valve cleaning...** Facilities for cleaning valves in the Ponca City plant are shown in an accompanying photograph. Valves are first placed in a wire basket and lowered into a vat which contains an appropriate chemical solvent. After treatment in the vat, the valves are removed and jetted with either a steam lance, high-temperature water lance, or a kerosine lance, as may be required.

**Cleaning fittings...** Flanges, nipples, some valves, and other fittings are chemically cleaned at the salvage yard before reissue. As shown in Fig. 1 and an accompanying photograph, three vats are used in this procedure; the first is filled with hot alkaline solution, the second is filled with acid solution at room temperature; and a third is filled with oil. Order of doing work is as follows:

1. The fittings are immersed in alkaline solution for removal of paint and grease.

2. After removal from the alkaline solutions, the fittings are given a water wash.

2. Next, the fittings are immersed in acid solution for removal of scale and rust. Inhibited HCl is used.

4. After the acid treatment, fittings are neutralized in alkaline solution.

5. Final neutralization is accomplished by steam cleaning with a steam lance. This also provides for the removal of any lightly adhering particles.

6. Fittings are finally dipped in light preservative oil to prevent rusting.

### Equipment for Cleaning

Various types of chemical cleaning devices have been adapted for various uses.

**Regular portable wagons...** Several chemical-cleaning wagons and pumps are mounted on trailer frames, thus making any location accessible for cleaning. A typical wagon is shown in an accompanying photograph, and details of the unit are shown in Fig. 2. This equipment is used for most cleaning. It is necessary to install some temporary lines for each operation. Some of the connections are made using chemical-resistant rubber hose.

Pumps are installed on the units since the cleaning solutions used are quite corrosive, and it is not deemed good policy to use regular process pumps for this work.

The chemical wagon can be used for exchangers, towers, pipes, and engine and compressor water jackets. They have also been used to remove scale from the water-cooling system on hot-oil pumps.

**Small portable wagons...** Several small chemical cleaning wagons are available for small chemical-cleaning jobs. One of these units is shown in an accompanying photograph.

The equipment consists of a 50-gal. drum, pump and motor unit, and attendant required piping. The units are used to clean water jackets on compressors; to clean the tube (water) side of some finned-tube exchangers; and to clean other units where limited working space is available and where small volumes of chemicals are used.

Advantages of the small units are found in the labor-saving devices. Since 110-volt electric power is used, no electrician is required to make the electrical hookups. The unit is hand pulled. A monel pump, rated 15 g.p.m. at 20 psi., is used.

**Permanent hookups...** There are several permanent systems installed in the Ponca City refinery for cleaning heat-exchange equipment. The most extensive of these consists of the tanks, pump, and connecting piping to the critical bundles of two light-oils units. This system is outlined in Fig. 3.

As shown in this diagram there are permanently installed discharge and return lines (2-in. and 3-in.) to and from the equipment. These lines are directly connected to the units that require cleaning most often. On other units a temporary hose or line is installed at the time of cleaning. Points of temporary connection are indicated on the diagram.

All coolers and condensers are cleaned on the tube side. The exchangers are all cleaned on the crude side, usually the shell side.

**Economics of permanent installation...** Chemical cleaning of bundles is compared to hand cleaning as follows:

**1. Hand labor, 50 bundle cleanings per year, total of material and labor is roughly $8,500 per year.**

**2. Chemical cleaning using temporary hookups:**

| | |
|---|---|
| Labor | $ 660 |
| Chemicals | 2,000 |
| Materials | 1,000 |
| (Roughly) per year | $3,660 |

**3. Chemical cleaning using permanent hookup as installed, costs $7,000 for installation, amortized over 10 years:**

| | |
|---|---|
| Installation | $ 700 |
| Chemicals | 2,000 |
| Labor | 100 |
| Materials | 50 |
| (Roughly) per year | $2,850 |

**Savings of chemical cleaning over hand labor if temporary hookup used: $8,500 — $3,660 = $4,840 per year.**

**Savings of chemical cleaning over hand labor using permanent hookup: $8,500 — $2,850 = $5,650 per year.**

**Savings of permanent hookup over temporary hookup: $3,660 — $2,850 = $810 per year.**

**Disadvantages...** The disadvantages of all these systems for chemical cleaning lie in the necessity for on-the-spot mixing of the chemicals in relatively small amounts, the corrosion of the cleaning pumps, and the repetitive piping jobs.

A plan is currently being surveyed for buying chemicals in tank-car lots and cleaning entire units directly from the tank car as it sits on a spur. Nearly every unit in the plant is available to a spur track. Preliminary economic calculations show this plan to be feasible.

Whether you are planning to build a completely new refinery, the addition of a new unit, or general plant remodeling—Macco Refinery Division is equipped to meet your requirements. The fifty-million cubic-foot wet gas handling and repressuring plant illustrated is a typical MACCO "grass roots" job. Starting from scratch at a miles-from-nowhere site, ground was prepared and all materials trucked in from supply bases 12 to several hundred miles away. Arrival was precisely timed to fit a most exacting construction schedule. The job was completed *on time*—proof that MACCO *does a job!*

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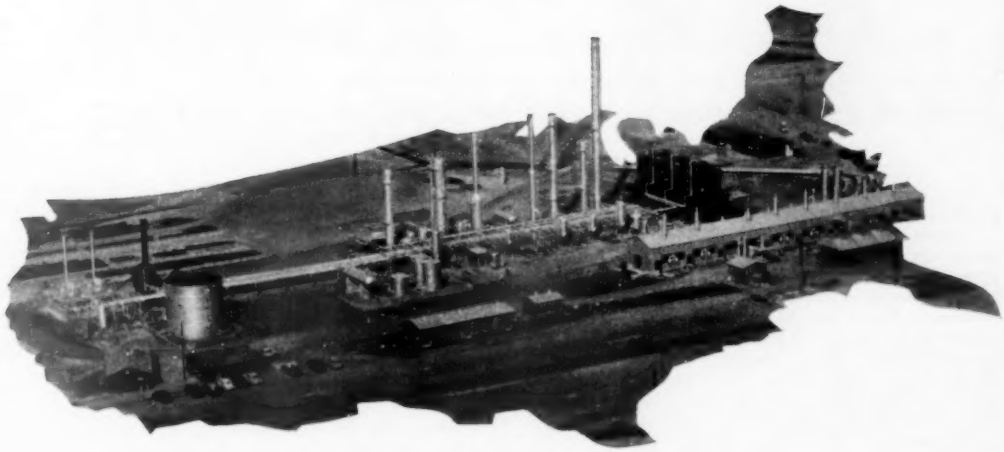

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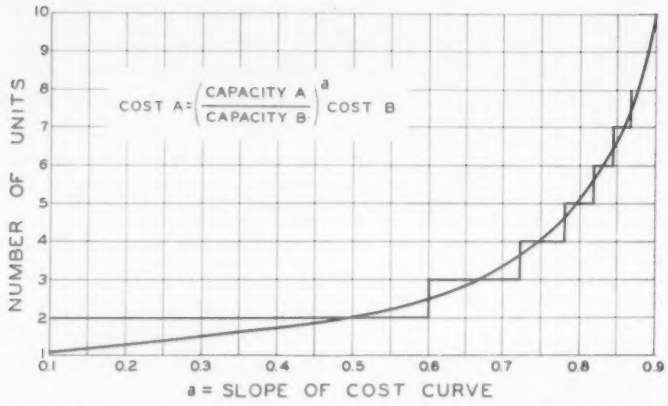


**Fig. 1—Optimum number of units for minimum capital investment where one spare unit is required.**

# What Price Spares . . . *in a refinery?*

**The problem of how much to spend on spare equipment is complex at best. While final answers are not attempted, methods outlined here will serve as an aid to judgment**

**by John E. Bell***

ONE of the knottiest and most frequently recurring problems to refinery engineers is how to justify permanently installed standby equipment. A request is presented for spare equipment based on the apparently sound logic that the expenditure of some relatively small amount of money for a spare pump, line, or exchanger may eliminate a major shutdown of a refinery facility and would consequently pay off in a day in the event that the regular service equipment were to fail.

On the other hand this argument, when carried to an extreme, might result in the installation of complete spares for all equipment with the result that capital investment in refining facilities would be doubled over that actually necessary to process the required amount of crude. Such a policy would, of course, bankrupt any company which attempted to follow it.

Economics is one of the factors which is involved in making a decision regarding the merits of installing a piece of spare equipment and it is the purpose here to demonstrate a method by which this one factor may be calculated.

In using an economic criterion to determine the advantages of installing a piece of spare equipment it should always be borne in mind that the factors of safety, future expansion, and other calculable considerations may outweigh in importance the question of economics. The installation of a piece of spare equipment may be made in a situation where economic calculations indicate that the proposed installation is not justified.

**Required information . . .** In order to calculate the economic advantage of the installation of a piece of spare equipment, it is necessary to have the following information:

1. Statistical data regarding the probability of failure of equipment similar or identical to that for which a spare is proposed. This is expressed as failures per year.

2. An economic study which provides an estimate of the loss resulting from a shutdown caused by equipment failure. This should be expressed as dollars lost per failure.

3. The cost of installing the spare equipment.

It is then necessary to assume a good value for payout. In the petroleum industry a 2 or 3-year payout before depreciation and income taxes is usually considered to be the criterion of a good investment. In some instances a longer payout may be acceptable. In order for the installation of spare equipment to be advantageous its cost must be less than the product of loss per failure, times failures per year, times years to pay out.

**Failure data . . .** Statistical data on the frequency of failure of particular types of equipment such as pumps, compressors, fans, etc., are not always available. However, an "educated guess" at this figure probably results in a more accurate analysis of the problem than an offhand guess at the entire question of whether or not a spare is justified.

Calculation of the loss resulting from a forced shutdown may prove to be major task when the problem involves an existing unit. Decisions regarding permanently installed standbys, however, are usually made during the design of a new unit. At such times economic studies are almost always available and can be used as a basis for the calculations.

One of the situations which is easily overlooked in considering problems of this type is the case where the refining facilities are not operated at their peak capacity in order to meet market demands. In the event that a particular facility operates at less than peak capacity, it is possible to catch up after a forced shutdown and as market demands are at all times met, there is little real economic loss resulting from the failure of the facility to operate continuously.

While it is questionable that the problem of the installation of spares has, in the past, been attacked by these methods, it is obvious that the collective judgment of the people who have made these decisions has been in accord with the results which would have been attained from more rigorous study. This is evidenced by the customs in the refining industry with regard to the installation of spares on electrical systems.

In most instances a continuous supply of electrical power is essential for continued operation of the entire refinery and thus a failure of the electrical system will result in a large loss in profit. Further, the cost of spares for transformers and switch gear is relatively small in proportion to the loss which may result from failure of this type of equipment. It thus appears

*Sinclair Refining Co., New York.

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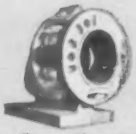

*Low-alloy casting, typical of applications where physical properties must be matched.*

*Alloy gear rim, typical application matching heat-treating properties of parent metal.*

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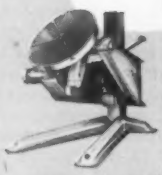

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logical to install spare equipment for electrical transformers and switch gear and a review of commercial installations will show that this policy is almost always followed.

**Cost considerations** . . . Another problem which arises particularly on a major project is how to provide spare equipment at minimum cost. An example of this problem would be the installation of a boiler plant in a refinery where it had been decided that a spare boiler is essential. If it is assumed that the normal steam demand is to be 1,000,000 lb. per hour, there are numerous alternatives which might be selected.

First, the installation might include two 1,000,000-lb. boilers thus providing for normal operation with spare equipment available in the event of failure. A second alternative would be the installation of three units each 500,000 lb. capacity. A third alternative would be the installation of four units each 333,333 lb. capacity, etc.

It will be noted that the alternatives listed all contemplate the installation of a multiple number of identical units.

**Mathematical solution** . . . The selection of the number of units depends on many factors. There are always special situations which are unique to particular problems and these must not be overlooked. There are, however, some factors which are involved in all such decisions. These are:

1. Safety, (2) operating costs, (3) plans for future expansion, and (4) capital cost.

This article will give consideration only to the matter of capital cost. A mathematical equation can be derived which will indicate the number of units which should be installed in order that the capital cost of the entire plant will be a minimum.

It must first be assumed that the capital cost of the units which will be installed in the plant is an exponential function of their capacity. This rule is accepted by estimators and it is discussed by Nelson in his series of articles on Costimating *(The Oil and Gas Journal, October 5, 1950)*.

This relationship is expressed by the equation:

$$\text{Cost A} = \left(\frac{\text{capacity A}}{\text{capacity B}}\right)^{a} \text{Cost B}$$

The exponent, a, varies with the type of equipment which is under consideration. Nelson gives a listing of exponents which he considers to be correct for various types of equipment. With this relationship accepted the

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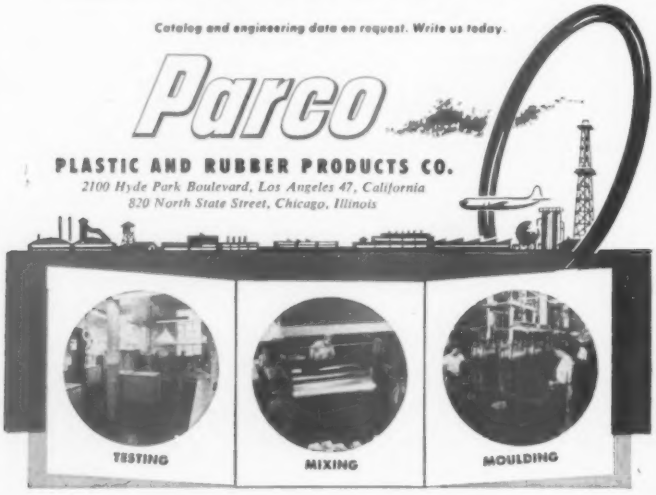


total cost of a multiple unit plant with one spare unit can be expressed as:

$$K = X^{a} Q (1/x + 1)$$

where

K = Capital cost of complete plant.
Q = Cost of a single unit with capacity equal to the normal design operating capacity of the plant.
X = Unit size expressed as a fraction of the normal design operating capacity of the plant.
A = Exponent of the capital cost equation.

From this equation it can be derived that K will be a minimum when

$$X = 1\text{-}a/a$$

The curve shown in Fig. 1 is a graphical representation of this equation. For convenience the ordinate is plotted as number of units, which is $(1/x + 1)$ rather than X. The abcissa is (a) the exponent of the cost, capacity equation.

**Example calculation . . .** In applying this procedure to the boiler plant for example, we select a value of 0.7 for a. This is the figure which Nelson recommends for complete plants and a large boiler would fall in this category.

In order to provide figures for an example, it will be assumed that a single boiler together with its auxiliaries having a capacity of 1,000,000 lb. of steam per hour would cost $5,000,000. Based on the exponential rule we can calculate the cost of the various alternatives as follows:

| | |
|---|---|
| 2 units | $10,000,000 |
| 3 units | 9,240,000 |
| 4 units | 9,280,000 |
| 5 units | 9,500,000 |

The three-unit plant involves the lowest capital expenditure. This may be verified on Fig. 1 for an exponent of 0.7.

In selecting an exponent consideration must be given to the cost of the entire installation.

As an example, consider the case of a small pump. Here the exponent according to Nelson for reciprocating pumps is 0.7. This would indicate that where a spare is required the installation should consist of three pumps. A more careful analysis will include the cost of foundations, piping manifolds, extra building space, etc. The cost of these items will be practically independent of unit size. The exponent for the cost of the entire installation will fall below 0.6 and the correct number of units to install for minimum capital cost is two.

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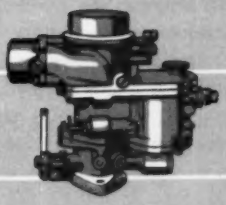

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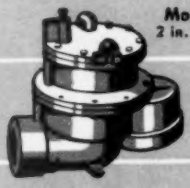
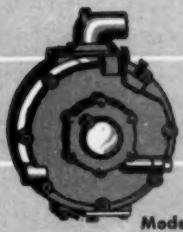


Model "B"
2 in. Regulator

Model ⅜ in. "Tg"
Combination Carburetor

Model "W" 55 H.P.
LPG Vaporizer & Regulator

Model "Xg"
Gas Carburetor



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# SPARE PARTS . . .

## How to Keep Track of Them

**A central control setup enables taking full advantage of interchangeability of spare parts and eliminates the purchasing of parts for each separate unit. The equipment and the spare parts, which are stocked for their protection, are set up in a catalog for each major unit. This catalog is a useful reference guide to the various departments because it indicates whether or not spare parts are carried for a particular piece of equipment and their physical location in the storehouse.**

**by J. P. Devine***

REFINERY equipment requires constant maintenance: breakdown of a single piece of equipment could mean shutdown of the entire unit with an accompanying loss in production.

With delivery of spare parts ranging from 6 weeks to 9 months and sometimes longer, it is a constant job to see that each piece of equipment is protected, with the spares for wearing parts in order to insure proper operation at all times.

**Problems involved . . .** The problems confronting anyone responsible for spare parts in a large refinery are multiple and complex. However, the job can be made much easier and will be more efficiently handled if, during periods of construction, the contractors are required to include on their purchase orders for equipment a request for a suitable number of parts lists, cuts or drawings, and recommended spare parts, indicating interchangeability. Such information has proved invaluable to those responsible for ordering spare parts and permits an earlier procurement than would otherwise be possible. In some instances parts can be on hand for the startup of units.

Due to the tremendous number of spare parts necessary to protect the operation of a large refinery, it seems logical that a centralized control should be set up so that full advantage can be taken of the interchangeability of parts, as frequently identical pumps or turbines of the same manufacturer are in service on several different units

*Sinclair Refining Co., New York.

FLUID UNIT — Page 11

Refinery East Chicago Location E-141 - Control and Pump House

Equipment Pump - Centrifugal Equipt.No. 437295.2

Manufacturer Pumps, Incorporated Serial No. Q-1473161

Purchased From John Doe - Manufacturer's Agent P.V.No.

Auth. No. EC-8108 Date 1946 Item No. P-16

Req'n. Date Price

Order No. N-1067-3506 Date 1946 Freight

Prime or Aux.Equip. Prime Aux. to(or driver) Equip.No. 118418-2

Date Received February 10, 1947

Name Plate Data : Other Data:

| | |
|---|---|
| Service | - Lean Oil |
| Size | - 2 AGT, 2-Stage |
| GPM | - 280 |
| RPM | - 3500 |
| Hd.Ft. | - 674 |
| Hyd. Test | - 600 |
| Including | - 1 - 2A "Slow" coupling |
| Bearings | - Thrust - No.7407-D<br>Radial - No.6212 |
| Packing Data: | |
| Shaft, rod, or plunger | - 17 chrome, 350 Br. |
| Packing style | - 100 M 5363 - Packing Assembly 111-L-151 |
| Stuffing-box dimensions | - 2½ x 3-9/16 x 5-5/16 - 9/16 |
| Material handled | - Hydrocarbon |
| Driven by | - Steam turbine, 85 HP, Serial No.12465, See Page T-27 |

We have Spare Parts List.
We have Inspection Report.

Fig. 1.

T-2RA #12465 — STEAM TURBINE, INCORPORATED TURBINE

Serial #12442 #12486
#12445 #12494
#12446 #15069
#12465 #15070

SPARE PARTS

PARTS LISTED ARE MINIMUM STOCK AND MUST BE REPLACED IMMEDIATELY WHEN WITHDRAWN

| | | PART NO. | QUANTITY | LOCATION | PRICE |
|---|---|---|---|---|---|
| Assembly | - Governor Valve Stem (Comp.) Dwg. #9893 | 207 | 4 | E-84 | |
| *Bearing | - Ball, Gov. Lever, H20304 | | 8 | CS6-151 | $3.20 ea. |
| *Bearing | - Exhaust end, Cat.#60 Dwg.#A-9238-1-2 | | 4 | D-67 | $17.90 ea. |
| *Bearing | - Main ball thrust, 309 RDT | | 8 | CS6-13 | $8.30 ea. |
| *Bearing | - Steam end, Cat. #58 Dwg. B-9312-1-2 | | 6 | D-40 | $23.20 ea. |
| Block | - Governor Lever | 218 | 12 | E-60 | |
| Connection | - Governor Lever | 217 | 6 | E-60 | |
| Lever | - Governor #9741 | 33 | 2 | E-13 | |
| Rings | - Carbon pkg. (6) Dwg.#A-38155-2, Cat.#46 | | 6 Sets | D-148 | $5.30 ea. |
| Shaft | - Turbine | 86 | 1 | 2nd Flr. New Bldg. | $175.00 ea. |
| Springs | - Speed Change | 132 | 18 | E-132 | $1.10 ea. |
| Spindle | - Gov., Cat.#6 Dwg. #V-30285 | | 12 | N-191 | $11.20 ea. |
| *Spindle Connections | - Gov., Dwg.V-13846 assembled; ea. consisting of:- | 14 | 6 | N-191 | $11.98 per set |
| 2 Cups | - Gov. knife edge Dwg. #A-42-1 | 15 | | | |

Fig. 2.

FLUID UNIT

Page 27

Refinery East Chicago Location B-141 Control and Pump House

Equipment Steam Turbine E.C.No. 115415.2

Manufacturer Steam Turbine, Inc. Ser. No. 12485

Purchased From Above P.V. No.

Auth.No. EC-5105 Date 1946 Item No. P-16

Req'n. Date Price

Order No. N-1057-9514 Date Freight

Prime or Aux.Equip. Aux. Aux.to (or driver). Equip.No. 437295.2

Date Received 12-4-46

| Name Plate Data: | Other Data: |
|---|---|
| Service | - Drive for Pumps, Incorporated, centrifugal pump, serial #01473151, see Page P-11 |
| Size | - 65 HP |
| Form | - T2RA |
| RPM | - 3500 |
| Steam | - 125# |
| Steam Temperature | - 403° |

We have Inspection Report 7/26/48

We have spare parts list, 12/10/46

Fig. 3.

2AGT PUMPS, INCORPORATED, PUMP

Serial No. 01473161
01473178
C-463020
C-463023
C-463028

SPARE PARTS

PARTS LISTED ARE MINIMUM STOCK AND MUST BE REPLACED IMMEDIATELY WHEN WITHDRAWN.

| | PART NO. | QUANTITY | LOCATION | PRICE |
|---|---|---|---|---|
| Bearings - Radial, No. 6212 | 205 | 2 | CS6-110 | $5.25 ea. |
| Bearings - Thrust, No.7407D | 204 | 4 | CS6-174 | $10.70 ea. |
| Bushing - Channel ring | 357 | 2 | G-8 | $14.50 ea. |
| Coupling - Slow | | 1 | M-248 | |
| *Rings - Casing (2 per set), Y-2AGT6CX1 | 6 | 8 | G-116 | $35.00 ea. |
| *Rings - Impeller (2 per set), Z-2HO4CX10 | 4 | 4 | G-143 | $17.50 ea. |
| *Shaft - | 10 | 1 | Top N Above Bin 56 | $125.00 |
| *Sleeve - Shaft (2 per set), Y-1G2SSAX9 | 8 | 2 Sets | G-170 | $44.00 ea. |

* Interchanges with Serial #C-463192-96 at the Straight Run Pract.
" " " #C-7473168-69 at the Poly Plant

Fig. 4.

throughout a refinery. If parts were ordered for each separate unit, and interchangeability disregarded, an unnecessarily large stock would be required.

**Equipment catalog . . .** In setting up a central control system it was decided that the best way to circulate complete information to all people concerned, would be to list all the equipment installed on a major unit in catalog form, using a separate catalog for each unit, and indicate thereon all spare parts that were being stocked for its protection.

The first step necessary in compiling this catalog involves a great amount of work in the field as it is necessary to have complete nameplate data, including serial numbers and acquisition references, so that requisitions will be complete when they arrive at the purchasing department.

Having completed the field work, the next step is to review manufacturers' recommendations, parts lists, and drawings. Next manufacturers' service engineers and plant operators and engineers are interviewed before requisitions are placed.

Having secured all of the information available, the catalogs are compiled. The catalogs consists of face sheets for each item of equipment which are indexed and alphabetically arranged by section and page number for convenience in locating items desired. The information appearing on these face sheets includes identifying numbers and general descriptive information together with other pertinent data such as bearing and packing information; also, whether or not we have inspection reports and drawings.

Following each face sheet is an unnumbered page or pages, showing the parts and their location in the storehouse by section and bin number or otherwise. These spare-parts sheets also indicate the serial numbers and the location of equipment on which they will interchange on other units. Figs. 1 to 4 are samples of the form used for the face sheet.

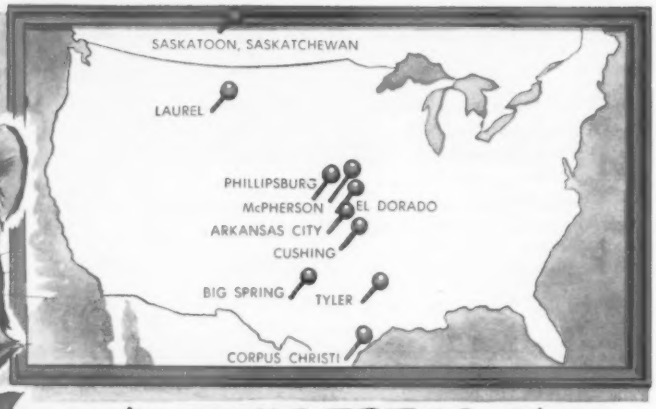
When catalogs have been completed, copies are distributed to the resident engineer, the storehouse, and sufficient quantities to the master mechanic for his distribution to the shops, area supervisors, and operating units.

The catalog serves as a useful reference guide for the mechanical foremen and operators, since they can quickly ascertain whether or not spare parts are carried for the particular piece of equipment being repaired and the location of spare parts in the warehouse. This is particularly useful when repairs are being made on week ends or at night when regular storehouse personnel are off duty.

Improvements in these catalogs are made continuously. It becomes necessary on occasion to adjust the minimum quantities that were originally established. When equipment is transferred from one unit to another, we have to remove its face sheet and set it up in the catalog that covers the unit where it is being installed. It is desirable to attach a tag to each spare-part item because a great many of these parts are very small and sometimes lose their identity.

The success of the system depends a great deal on the cooperation of the storekeeper and the storehouse personnel. It is obvious that the initial location of spare parts should be permanent. If parts are being continuously relocated, an undue amount of work is involved in marking new locations in all the catalogs.

Obviously the investment in spare parts is inversely proportionate to the degree of standardization of equipment and considerable improvement could be obtained in this regard by more careful consideration in the initial selection of equipment.

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- El Dorado Refining Company, El Dorado, Kansas
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## Maintenance Priority System

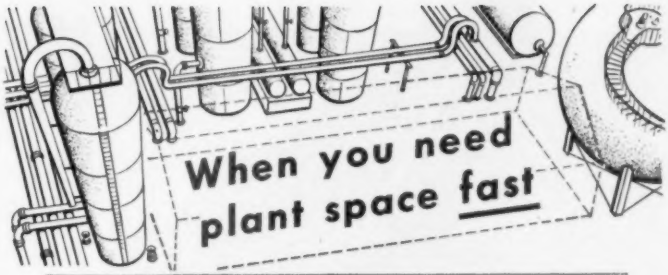
*(Continued from page 209)*

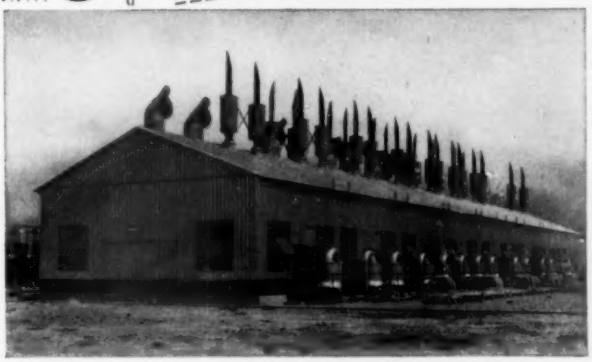
level, the alphabetical classifications would be reviewed and numerical prefixes attached in accordance with importance in maintaining plant production. The problem posed by the two zone requests for a similar job would be solved at this meeting. The assistant process superintendents concerned could decide which of the two requests should receive the top priority, and then eliminate the confusion.

The regular coordinating committee thereupon receives the tentative lists from the process meeting and finalizes its program for the following day. Changes are made to the priority list from the other committee meetings as well as from other groups represented at meeting. An example might be a high-priority job involving modification of heat exchangers on a unit. The engineering department representative might recommend a much lower priority due to a late shipping date on special alloy tubes required in the bundles. The technical department, on the other hand, might have completed work on a problem dealing with heat balances, which if employed on the unit in question, might call for a rearrangement of flow lines and change in heat-exchanger requirements, thus an entirely new approach would change the priority.

These examples show the value of the coordinating committee, for instead of work proceeding on the heat exchangers, as might have happened if the zone process foreman worked directly with the mechanical department, the opportunity for all departments to be kept informed permits the coordination of several efforts to solve a common problem.

**Successful . . .** The coordinating committee has been in existence a relatively short 2 years, but its beneficial effects have been felt to an increased extent in the better utilization of manpower. With the one centralized group aware of all projects, both major and minor, either contemplated or under way, the necessary items will receive their proper attention. With a method which left decisions of priority to operating groups or various crafts, and sometimes on a "first come, first served" basis, essential jobs would often be crowded out. On the basis of the improved results noticeable since the committee was first instituted and the continuing improvements in the maintenance and construction programs, Magnolia's management has been enthusiastic in its support of the present setup.

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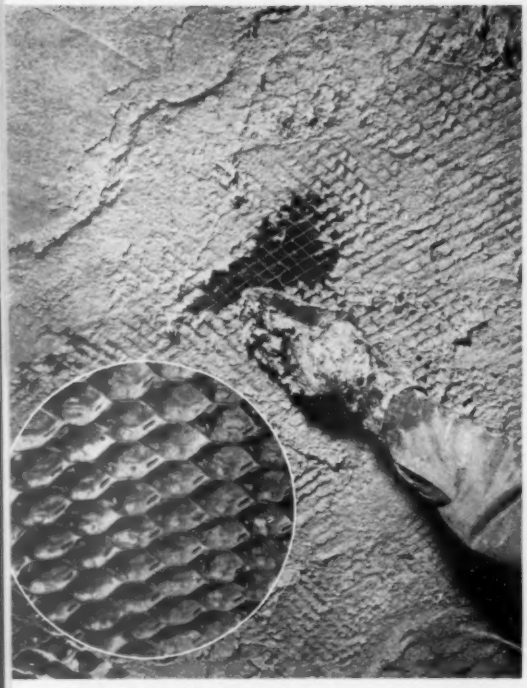
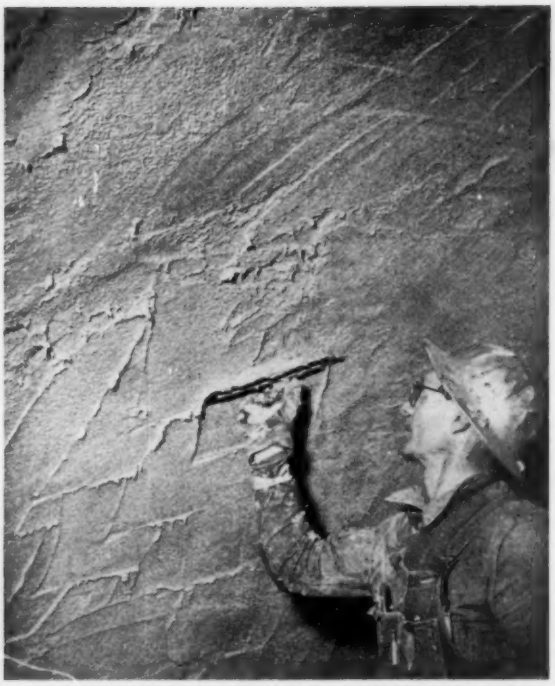


APPLYING ACIDPROOF CEMENT to grating and wire-mesh-covered dome of the vacuum flasher. Inset shows how projections and holes punched in grating serve as anchoring means for cement.



LIGHT TROWELING was used to finish the cement to a semirough surface. Excessive troweling was found to result in pulling the cement away from the hexagonal grating. Coating is a sodium silicate type of acid-proof cement.

# Acidproof Cement Lining Halts Corrosion

## . . . *in vacuum flasher column*

Shell finds satisfactory solution to serious corrosion problem at its Wilmington refinery. Cost of installing the cement lining one-third that of alloy cladding

**by D. H. Stormont**
West Coast District Editor

USE of an acidproof cement lining apparently is the solution to a serious corrosion condition encountered in the vacuum flasher column at Shell Oil Co.'s Wilmington, Calif., refinery.

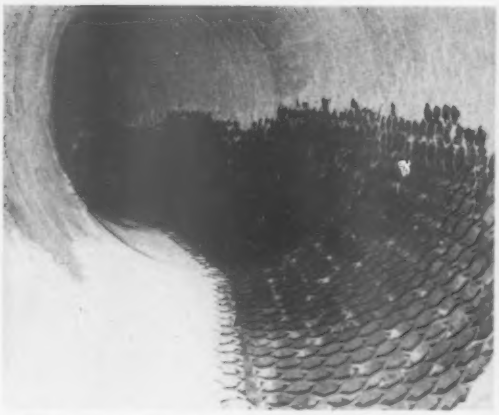
Portions of the tower have been lined with the material for as long as 18 months; the entire column has been protected since April 1952. When the lining was inspected during a recent shutdown, no evidence of cracking or spalling was shown.

The problem is primarily one of high-temperature sulfur corrosion, although there is some evidence of erosion in the feed inlet lines. The sour vapors flashed from the stripped crude quickly attack the unprotected 20-ft.-diameter steel column.

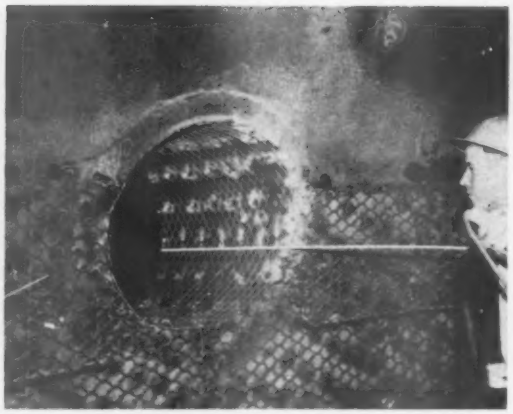
Lining with acidproof cement thus appears to be a successful means of protecting such thin-walled vessels, in the absence of appreciable moisture. Actual service life is yet to be determined but the cement apparently will prove more economical than steel. Cost of installing the lining is about one-third that of cladding with alloy steel.

**Gunite experiences . . .** In making internal revisions to the column in April 1948, a gunite lining was installed for the protection of the ½-in. shell and the structural reinforcing members. The area covered included that part of the shell below the feed inlet nozzle together with the bottom hemispherical head.

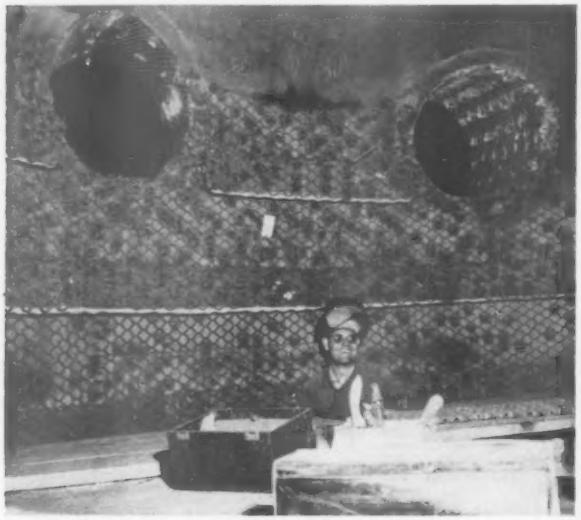
Carbon-steel star crosses, 8 by 8 in., were welded to the shell and head, on a 90° pitch and with a 4-in. center-to-center spacing. A gunite mixture of three parts crushed fire brick and one part portland cement then was applied to a thickness of about 1 in. After air drying with an aspirator for 8 hours, the lining was steam cured for 40 hours at atmospheric pressure and



**FLOOR GRATING** in catalyst line gets an application of acidproof cement. The entire thickness was applied on one application, and each hex was completely filled.



**FLASHER COLUMN** and vapor-outlet line, showing detail of floor grating prior to applying cement. Dark spots on shell show where grating was tack welded.



**GENERAL VIEW** of floor grating installed prior to applying acidproof cement. Dark spots show where grating was tack welded.

**JOB COMPLETED** in flasher column except for dome above vapor-outlet lines.

then air dried for 5 more hours without an aspirator.

When inspected after 228 days of service, spalling had occurred in several small areas. Some crosses were exposed but the underlying gunite appeared dense and intact so that no repairs were made.

In September 1949, after a total of 496 days' operation, inspection showed essentially the same conditions as before except that the exposed crosses were severely thinned by corrosion. The gunite was still intact although numerous small cracks had appeared in the lining on the shell and several large cracks were observed in the covering over the structural reinforcing rings.

The gunite lining demonstrated it could be used satisfactorily but that its service life left much to be desired. Accordingly while portions of the gunite lining were being repaired a block of the acidproof cement was installed in June 1950 to test its endurance. Later inspections revealed the block to show no flaws while the gunite lining continued to crack and spall.

As the gunite lining failed it was replaced in kind, pending results of the acidproof-cement test block. In January 1951, the upper section of the column heretofore unprotected was lined with acidproof cement. In April 1952, all gunite was removed and the remainder of the vessel lined with acidproof cement. In October 1952 all acidproof cement lining was found in excellent condition.

**Method of applying...** The material used was Gladding, McBean & Co.'s. "Fibrazist," first used as an erosion-resistant cement. The cement is a sodium silicate type of acidproof cement with the powder being essentially silica with asbestos fibers added for better

workability. Mixed in proper proportions they quickly set to form a monolithic protective lining.

First step after cleaning the shell was to tack-weld a ¾-in. hexagonal steel grating to the vessel shell, on a center-to-center spacing of about 6 in. This was to give the cement vertical support while being applied and to provide a means of anchoring after the material had set. Wire mesh also was used over grating in lining curved top dome to hold cement in place.

The grating at Shell's request was purposely loose-riveted to make it more flexible. Strips of the grating can be rolled to fit inside 20-in. openings.

Another provision is the anchoring surface provided by small fingers pressed from the unriveted sides. Extending beyond the smooth steel grid, these fingers tend to prevent the unset cement from sloughing. Then after it is set they serve to anchor the cement in place.

With the grating welded in place the acidproof cement was applied, care being taken to assure that each hex was completely filled. The entire thickness was applied in one application, with the cement being allowed to extend about ¼ in. beyond the grating. The surface then was troweled lightly to a semirough finish before the initial set took place. Within 24 hours from the time of application the lining had been cured and was ready for service.

**Application technique . . .** Because of the fast setting time—about 15 minutes at atmospheric temperatures of 90° F. and 45 minutes at 65°—the cement was batched-mixed as needed. Any cement remaining after the initial set had started was discarded. Care was exercised at all times to keep the surface clean and dry.

Usually the workmen used a rubber-gloved hand to push the cement into the cavities. It then was troweled lightly; attempting to trowel to a smooth finish generally resulted in material being pulled out of the grating. The full thickness of approximately 1 in. was built up before the initial set occurred. This was found necessary as fresh motar does not bind well with a dried coating.

Shell previously has used the flexible grating and acidproof cement to line interiors of catalyst lines and other parts of Wilmington fluid cracking plant where catalyst erosion was a problem. In this use the material has given much better service than steel liners. Some lines have been coated with the cement for more than 3 years. On a recent inspection it was found that at some points erosion had removed material above the grating but that imbedded in grating was intact and free of cracks.

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MOBILITY ON PARADE at Humble's yard, as 34 of the 41 pieces of equipment assigned to the rigging department pose for picture. Additional equipment is assigned to the garage, storehouse, and labor departments.

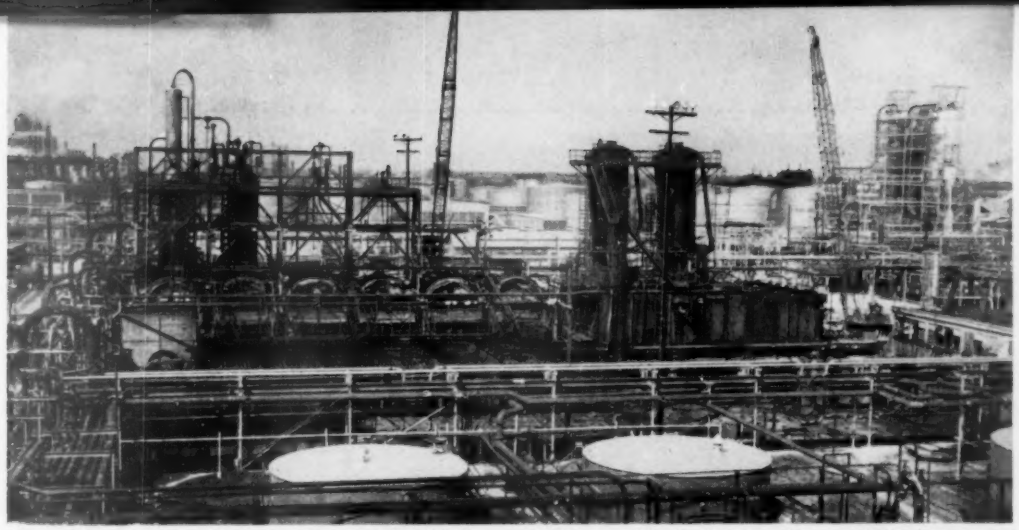
FROM PICKUP TRUCKS TO LOCOMOTIVE CRANE

# Mobile Equipment . . . Key to Humble's Maintenance Program

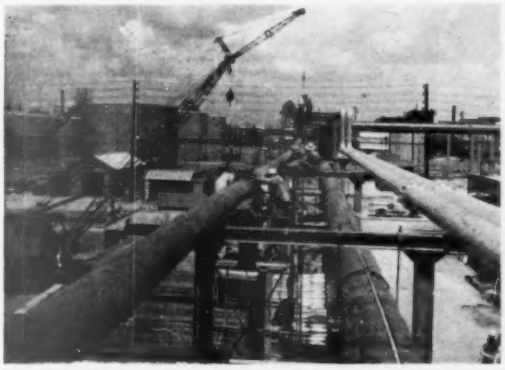
by F. Lawrence Resen
Gulf Coast Disrtict Editor

MOBILITY is the key to keeping a large-scale maintenance program running smoothly. At Humble Oil & Refining Co.'s Baytown, Tex., refinery the maintenance and construction division utilizes a wide variety of mobile equipment. The rigging department alone uses 41 mobile units, about a third of the equipment on hand. This department, responsible for moving of machinery and equipment required in plant-wide construction, uses equipment ranging from a locomotive crane to a pickup truck.

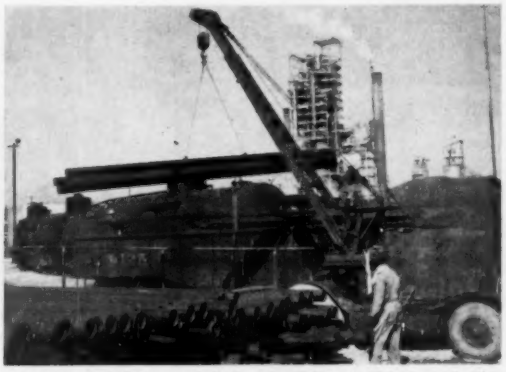
A tube bundle from a heat exchanger, a slide valve from a cat cracker, a new fractionating column, or a storage tank—all must be moved at one time or another, and each poses a different problem in its transit. With the wide variety of mobile equipment available, the riggers are able to perform these tasks in short order with a minimum of delay. Additional time



**CRAWLER CRANES, two of them, hard at work at Humble's Baytown refinery, dismantling an old battery. The 100-ft. booms are capable of reaching far into the unit to provide hoisting power as required.**



**MOBILE CRANE is performing one of the many functions in supporting piping during installation. Crane was used to lift pipe to supporting stanchions.**



**SMALL CRANES are used to lift small loads such as unloading pipe from car. This unit can easily clear adjacent fence with load and deposit on rack.**

is saved with the use of two-way radio transmission allowing dispatcher to communicate directly with individual units as service requests are received.

The mobile equipment, whether in use on a major turnaround project or being used to transport a joint of pipe for a minor repair job, has proved so efficient that many new pieces of equipment have been added at Baytown in the past several years. Adaptation of new developments in rigging machinery to plant maintenance requirements has enabled a superior type of service to be provided in plant maintenance and construction work. Greater job planning and more efficient coordination of maintenance work have been instituted and these have combined to provide more economical operations.

**LOWBOY TRAILERS are useful in handling cumbersome loads. In the picture at bottom of opposite page two were necessary to handle the heavy drum. In the view at left, moving the storage tank within refinery grounds provides some tight squeezes.**

**Straddle carriers . . .** One of the most efficient pieces of equipment employed in the refinery is the straddle carrier. Five of these are being used in the rigging department, each capable of carrying loads of 30,000 lb. on pallets. The vehicles conveniently straddle large, cumbersome objects and with a minimum of effort move them to any desired location.

Their use in moving heat-exchanger

**STRADDLE CARRIER** is shown on roadway within central shop with load of pipe. Small hoist in foreground is one of many in shop.

**STRADDLE CARRIER** handling tube bundles. The carrier is driven over the load, previously mounted on a pallet, lifts it clear of ground, and in a matter of seconds is on its way.

tube bundles is especially noteworthy. Moving the long, awkward bundles by truck is difficult and time consuming and the bundles must usually be handled several times. With a straddle carrier the task may be accomplished simply and rapidly.

**Cranes . . .** Mobile and crawler cranes provide crane service to any part of the refinery in a matter of minutes. Load capacities of the 12 mobile and 4 crawler cranes at the plant vary from 1½ tons up to 40 tons. Heavier loads may be accommodated by using guy derricks, which may be erected at any required site. Although guy derricks are not portable in the same sense as the mobile equipment, they are moved about the plant as required. In fact, some of the straddle carriers and mobile cranes are used in transporting and erecting the derricks.

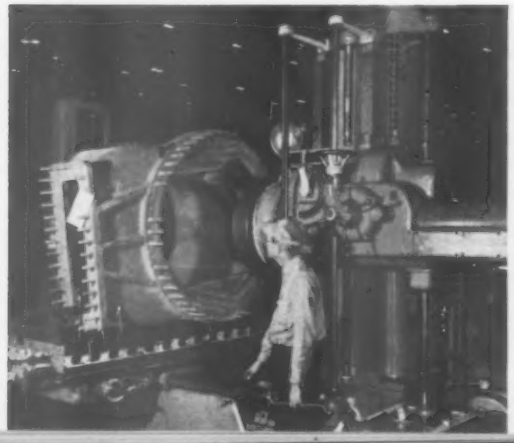
**Trucks . . .** Various types of trucks are included in the equipment list of the riggers. These include several pickups, boom trucks, and Army-type six-by-sixes. To haul extremely heavy or bulky loads, specially fabricated low-boy trailers are in use. These heavy-duty carriers may be used individually or in combination to support and move loads impractical to handle by truck. Tractors or bulldozers couple to the trailers to supply motive power. Other equipment on hand at Baytown includes side-boom tractors, earth-boring machine, trenching machines, tractor-mounted back hoes, graders, load luggers, front-end loaders, fork-lift trucks, and self-loading trucks.

**Job outline . . .** To facilitate handling of maintenance work, the riggers follow job procedure, set down in book form, which outline a step-by-step method to follow in performing various jobs. The manual contains data on strength, weights, and safe loads of materials handled daily. In addition to giving a method to follow in performing a job, a listing is made of all equipment—mobile units, tackle, jacks, chains, etc. —which will be required in the work so that no time will be wasted in trips for additional equipment once the work has begun.

**Central . . .** Once equipment has been removed for overhaul, it is processed through Humble's king-size central shop. Straddle carriers and trucks may drive directly into the shop to deposit their respective loads. Overhead cranes capable of lifting 15-ton weights can thereupon move the equipment to the various machining units as overhaul work proceeds. In addition to the overhead traveling cranes, the shop is equipped with many small hoists, mounted on jib cranes, which provide for the handling of small pieces of equipment during the actual overhauling operations.

With the availability of the mobile equipment and the utilization of it in the performance of maintenance work, savings are apparent in both the time and effort necessary to complete a job and also in the decreased downtime of any particular unit. The end result is the maintaining of plant production at highest maximum rate.

**FORTY-TWO-INCH SLIDE VALVE** is typical of equipment which must be handled in plant-wide maintenance program.

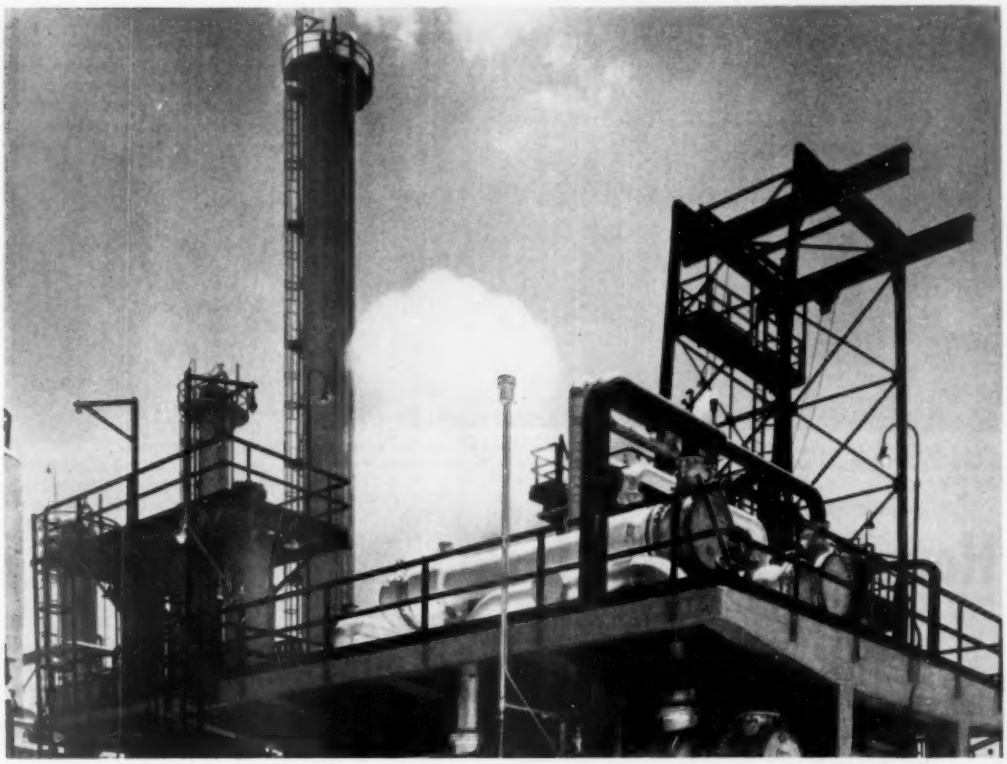


**RIGGING-CABLE ROOM** houses thousands of feet of wire line used by various pieces of lifting equipment.

# *refrigeration*

## puts new life in alkylation at Sinclair Oil

During World War II, the Sinclair Refining Company built a huge hydrofluoric acid alkylation unit to speed the supply of high-octane gasoline to our armed forces. When the war ended and the demand for special high-octane fuels dropped, the unit could no longer be operated at a profit. So Sinclair shut it down. • Recently this Sinclair alkylation unit was reactivated but with a difference that now makes it profitable. That difference was the addition of refrigeration to the process. • With refrigeration, Sinclair engineers found they could increase both the quantity and the quality of their gasoline. For the



refrigeration cycle they chose a Carrier Centrifugal Compressor with butane as the refrigerant. Because the Carrier Centrifugal could be driven by a turbine, they used exhaust steam that otherwise would have been wasted. • The result: power for the refrigeration now costs them practically nothing. Maintenance costs are negligible. Reliability is unmatched. • Would you like to learn more about the profit potentials of these Carrier Centrifugal Compressors? Write for our new booklet, "Centrifugal Compressors for Industry." It makes profitable reading. Carrier Corporation, Syracuse, New York.

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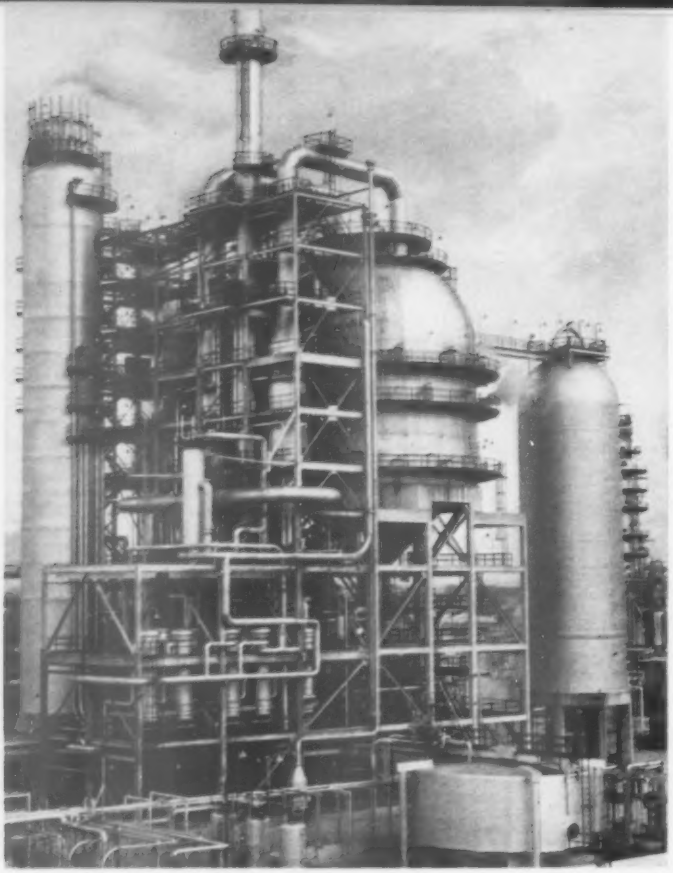


MOST RECENT of the fluid catalytic cracking plant designs is the Model IV unit, one installation of which is pictured here. This is one of the latest developments in the catalytic cracking field.

# How to Combat Erosion

## . . . in fluid cat crackers

**Refiners accept erosion as a routine maintenance matter, and report plant runs of better than two years. Here's how one company carries on the fight.**

**by J. S. Clarke**

RATES of catalytic transfer between the vessels in the fluid catalytic cracking process may be as high as 70 tons per minute and the velocity of catalyst-laden gases up to 120 ft. per second, sometimes higher. In view of this, erosion might be expected to be an insurmountable problem. Fortunately the degree of erosion actually experienced falls far short of what might be envisioned and erosion has never been a major problem in the fluid process.

Considerable progress, however, has been made in reducing and combating erosion since the original plants were put in operation. As a result, in the light of present-day experience, erosion is now accepted as a routine maintenance matter. Plant runs of 2 years and over are now quite common for the typical fluidized solids system shown in Fig. 1.

**Erosion tests . . .** Various test programs were carried out by Standard Oil Development Co. in connection with early plant operations in an attempt to evaluate some of the uncertainties regarding erosion. One of the first was a laboratory program in which a jet of catalyst-laden air was made to impinge upon sample plates of various metals to determine relative erosion rates.

A similar program was carried out simultaneously in plant equipment. In the plant tests, spindles carrying disk speciments were installed in dilute-phase high-velocity catalyst lines. The following results are considered significant from these tests:

1. Erosion on the reactor side of the unit takes place in an atmosphere of mild corrosion. Here, erosion appears to be accelerated by corrosion. On surfaces not subjected to erosion, however, there is negligible corrosion. On the regenerator side of the unit, conditions are almost exclusively of an erosive nature. In view of this, materials have a different order of merit for reactor-side conditions than for regenerator-side conditions.

2. Forty-eight metallic specimens were evaluated as to relative loss rate under reactor-side conditions. Carbon steel, arbitrarily taken as the reference standard, rated forty-third place in the list in order of merit in resisting erosion.

3. For regenerator-side conditions, of 48 metallic specimens tested, carbon steel rated eighth place in order of ability to resist erosion.

4. In general, the test results showed the high carbon-high chromium irons to offer the best resistance to erosion. Chrome-plated steel showed excellent resistance but was not considered a practical construction material. High-alloy steels containing chrome, chrome-nickel, etc., generally showed poor resistance to catalyst erosion but were superior to carbon steel when some element of corrosion was also present. Nonferrous materials such as bronze showed poor erosion resistance.

5. The actual metal loss by erosion is influenced to a marked degree by the angle of impingement, with maximum loss at an angle of about 25°.

6. Erosion increases very rapidly where the catalyst is in dense phase with velocities above 5-7 ft. per second and in lightly loaded gas or vapor lines with velocities above about 120 ft. per second.

**Use of nonmetallic castables . . .** Following this work, an investigation was made to determine the ability of nonmetallic castable refractories to resist erosion. There was considerable economic incentive to develop this type of wear plate in view of the cheapness of materials involved and the ease of

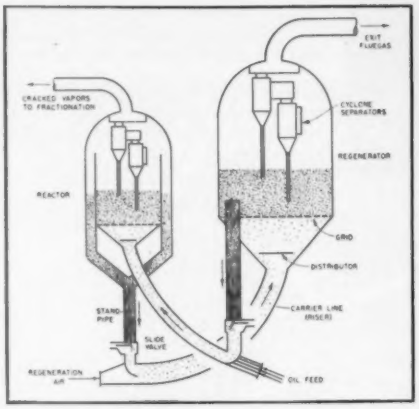



**Fig. 1—Typical fluidized solids system as applied to catalytic cracking.**

**Fig. 2—Installation of supported castable liner.**

installation. Test panels were installed at various points in operating plants where failure would not adversely affect operations.

From the very start, this type of liner gave promising results in resisting erosion. In the construction finally developed, a commonly available hexagonal steel mesh approximately ¾ in. thick is attached to the surface to be protected by intermittent welding and the mesh filled with a dense refractory castable. It is preferable to install the castable by pneumatic gun rather than by hand troweling to insure fill and maximum density.

Fig. 2 illustrates the construction employed. This installation has been in operation for one or more plant runs and will be referred to later in the discussion. Experience has indicated that it is necessary to finish the castable flush with the surface of the steel mesh as any overlay will result in spalling.

An unexpected advantage of the castable wear plate was the manner in which erosion took place. Metal plates were found to erode by gouging or channeling and it appeared that any gouge or channel once started was self-accelerating. Thus, a steel plate would fail by cutting through completely at some point while the rest of the plate might be but slightly eroded. The supported castable plate, on the other hand, was found to erode more or less uniformly. From that point on, metallic wear plates and liners were replaced by supported castable rather generally.

Fig. 3 is a schematic diagram showing the principal items comprising the cracking section of a typical fluid catalyst cracking plant. Points where erosion takes place or might be expected are indicated.

**James S. Clarke is a mechanical engineer with Standard Oil Development Co., a position he has held since 1946. Prior to the latter date he was process engineer with the company. He is a graduate of Rutgers University, from which institution he holds both B.S. and M.S. degrees. Shortly after graduating he joined the faculty of Rutgers, and following 4 years of teaching, he joined S.O.D.C.**

### Slide-Valve Erosion

In standpipe service, erosion of the valve takes place on the leading edge of the slide, at the valve seat, and in the outlet of the body opposite the slide. If the pressure drop across the valve is kept below 5-6 psi. runs of a year or more may be expected using carbon-steel construction throughout.

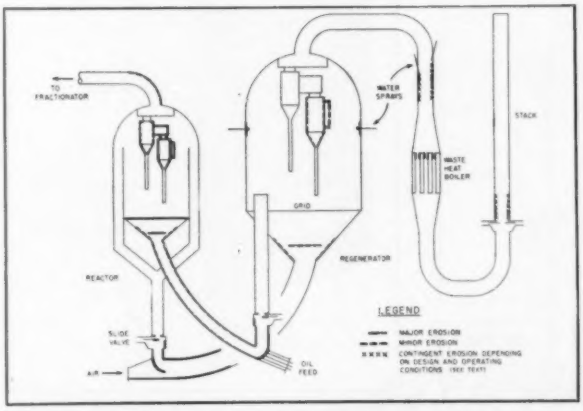



**Fig. 3—Points of erosion in fluid catalytic cracking plant equipment.**

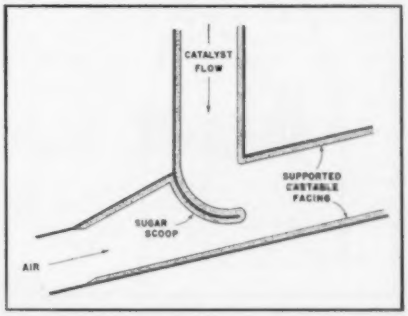



**Fig. 4—Installation of "sugar scoop."**

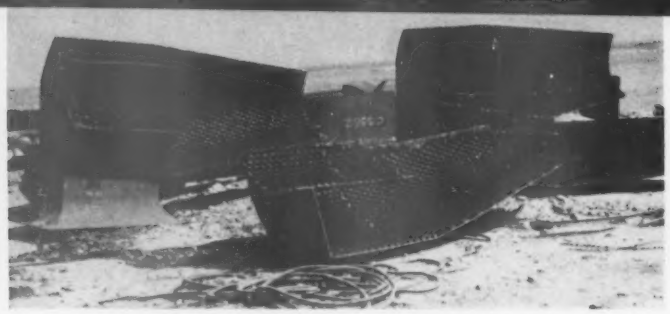


Fig. 5—Cyclone with complete liner castable not yet installed.

Where pressure drops are above this level, considerably higher rates of erosion may be expected and one of the metals superior to carbon steel should be used for the slide and seat.

Depending upon the material employed, the parts subject to erosion may be made entirely of this material or merely be faced with it. In any case, a supported castable wear plate should be installed on the inside of the body downstream of the slide covering about 180° opposite the slide.

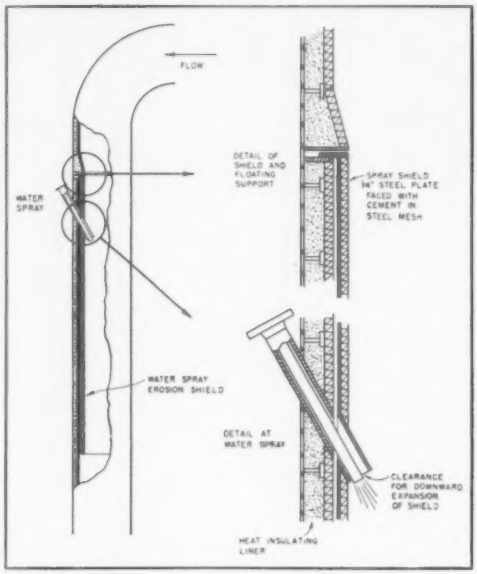
The present trend in plant design is to use carbon steel and limit the pressure drop to values where erosion is not excessive. Carbon steel is cheaper in first cost and is repaired readily by depositing metal and machining. Where the over-all pressure drop to be taken is above 6 psi. or where plant runs are limited consistently by slide-valve erosion, dual valves may be installed. With two valves, the total pressure drop can be split between them, or, alternatively, one valve may be used until it becomes ineffective for control and then the spare valve brought into service.

In properly engineered applications, erosion of slide valves in flue-gas service is not likely to be a problem provided the pressure drop does not exceed 6-8 psi. In view of the high velocity issuing from the valve restriction, particular care must be taken in the design to avoid impingement on the line or stack downstream of the valve. Normal practice is to use a dual slide type of valve in this service to maintain center-line flow. Also, the stack or line downstream of the valve should be sized for a maximum velocity of about 100 ft. per second in order to avoid exceessive impingement as the gas expands leaving the valve restriction.

Where more than one valve is used in the stack, they should be so spaced that the discharge from the upstream valve does not impinge on the internals of the downstream valve. A spacing of about five line diameters has been found to be sufficient to insure against this.

### Grid Erosion

The grid is a flat or contoured plate having many holes to distribute the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WATER SPRAY EROSION SHIELD
DETAIL AT WATER SPRAY
CLEARANCE FOR DOWNWARD EXPANSION OF SHIELD
HEAT INSULATING LINER

Fig. 7—Full floating erosion shield in regenerator flue gas line at water sprays.

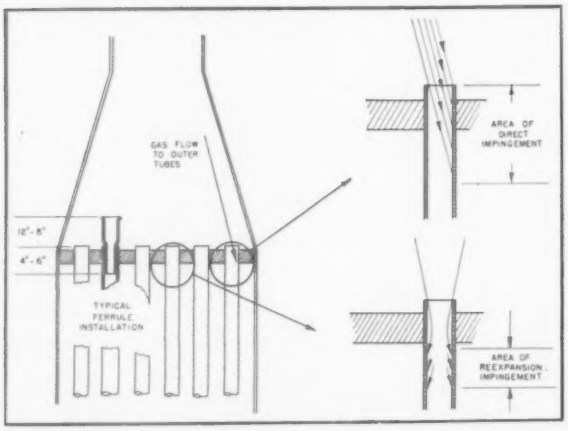


Fig. 6—Mechanism of erosion in waste heat boiler tubes and means of prevention by use of ferrules.

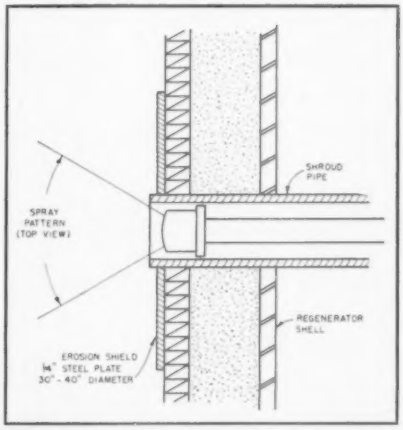


Fig. 8—Recommended installation of regenerator spray to minimize erosion.

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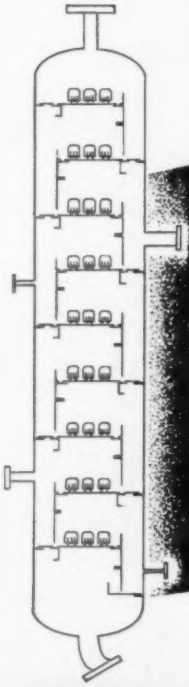

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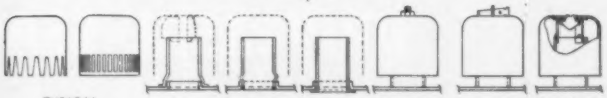


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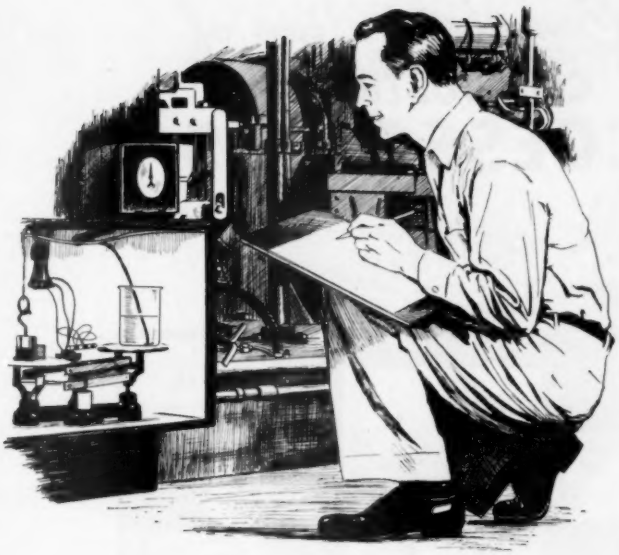

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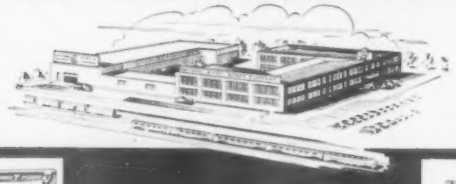

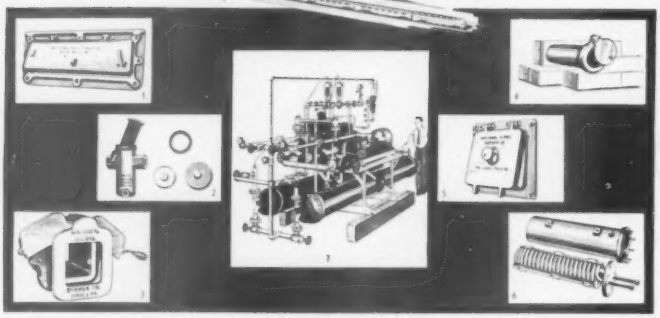

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incoming gas evenly throughout the catalyst bed. Present-day practice is to use holes of sufficient size to minimize plugging, 1½ to 2 in. in diameter, and to design for pressure drops of about 1 psi.

Erosion of the regenerator grid has never been a particular problem. Many units have operated for as long as 10 years without replacement or major repairs to the regenerator grid due to erosion. In these cases, the grid material was high-tensile-strength cast iron or 4-6 chrome-moly steel.

Reactor grid erosion is more severe and major repairs are usually necessary after a plant run. The use of carbon steel for the reactor grid is felt to represent the most economical practice due to low cost and ease of repair. The use of expendable ferrules in grid holes has been tried but generally this has not been successful.

**Inlet distributors . . .** It is desirable to provide an inlet distributor below the grid to improve initial distribution and prevent direct impingement of the incoming stream on the center of the grid. Many types of distributors have been tried. The most successful to date has been a flat plate faced entirely on the upstream side with supported castable.

It is preferable to support the distributor from the grid rather than from the vessel in order to protect the supports from erosion. This is particularly true on the reactor side where some element of corrosion is likely to be present. If the distributor is supported from the vessel, the struts should be protected with a layer of supported castable.

Conical distributors are used quite generally but are apt to be more subject to erosion since the angle of impingement is closer to the critical value then with a flat plate.

**Injection points . . .** Turbulence and change of direction greatly accelerate erosion. Both of these factors will be present at the oil and air injection points. One of the most effective means of reducing turbulence here is by the use of a so-called "sugar scoop" or turning vane at the base of the standpipe (Fig. 4).

This is a patented device developed by Standard Oil Development Co. in connection with early plant operations when erosion at the injectors was limiting run lengths. All internal surfaces are faced with supported castable.

### Cyclones

In the original and early units, the the catalyst in the outlet gases from the reactor and regenerator was re-

moved by cyclonic action in a bank of many small-diameter tubes. Erosion of these tube assemblies was a severe maintenance problem. In view of this and for other reasons, the trend has been away from this type of separating equipment. Large - diameter - type cyclones now are used generally in new units and for supplementing or replacing the multiple tube units.

From the standpoint of erosion, it is desirable to limit the inlet velocity in cyclones to 60 ft. per second on the reactor side and to 75 ft. per second on the regenerator side. On this basis, erosion of regenerator cyclones is extremely low. For reactor cyclones, where varying degrees of corrosion will be present, initial experience indicated the need for erosion protection in the conical section below the barrel. A supported castable lining served very well at this point. The cyclone was flanged at the junction of the barrel and cone to permit convenient inspection and maintenance.

Subsequently, on increasing plant throughputs, which gave higher velocities than indicated above, it was necessary to line the first stage cyclones completely. As a result of this experience, it is now becoming general practice in new installations to completely line reactor-side cyclones. This permits reducing the thickness of the steel from ½ in. to ¼ in.

Fig. 5 shows a cyclone with the steel mesh installed prior to applying the castable material. In this case, the cyclone has been cut to permit passage through the vessel manhead.

**Waste-heat boilers . . .** Erosion in waste-heat boilers is caused by two factors. First, there will be reexpansion impingement on the tube walls just beyond the inlet of the tubes. Secondly, there is usually a conical section in the flue gas line entering the waste-heat boiler which causes the gas entering the outer tubes to impinge on the outer sides of the tube.

Fig. 6 indicates both of these effects. To resist erosion from both of these causes, steel ferrules are installed at the inlets to the tubes. Fig. 6 shows a typical ferrule installation and representative dimensions.

### Overhead Lines

Lines carrying gas lightly loaded with catalyst are subject to erosion at points of turbulence and change of direction. If velocities are kept below 120-140 ft. per second, excessive erosion should not be encountered in regenerator flue-gas lines. On the reactor side of the unit, however, the added effect of corrosion may require that wear plates be in-

*(Continued on page 272)*


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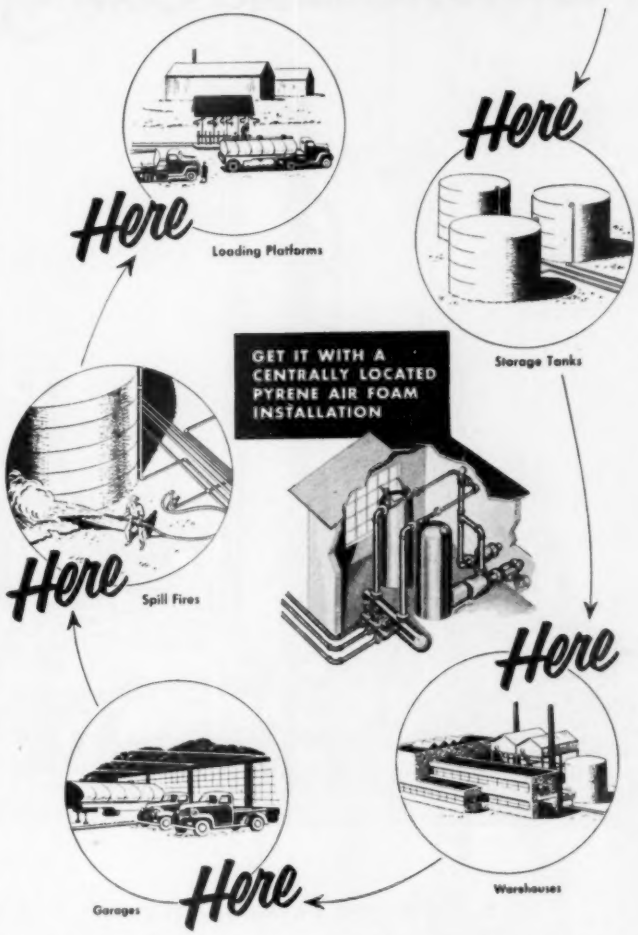


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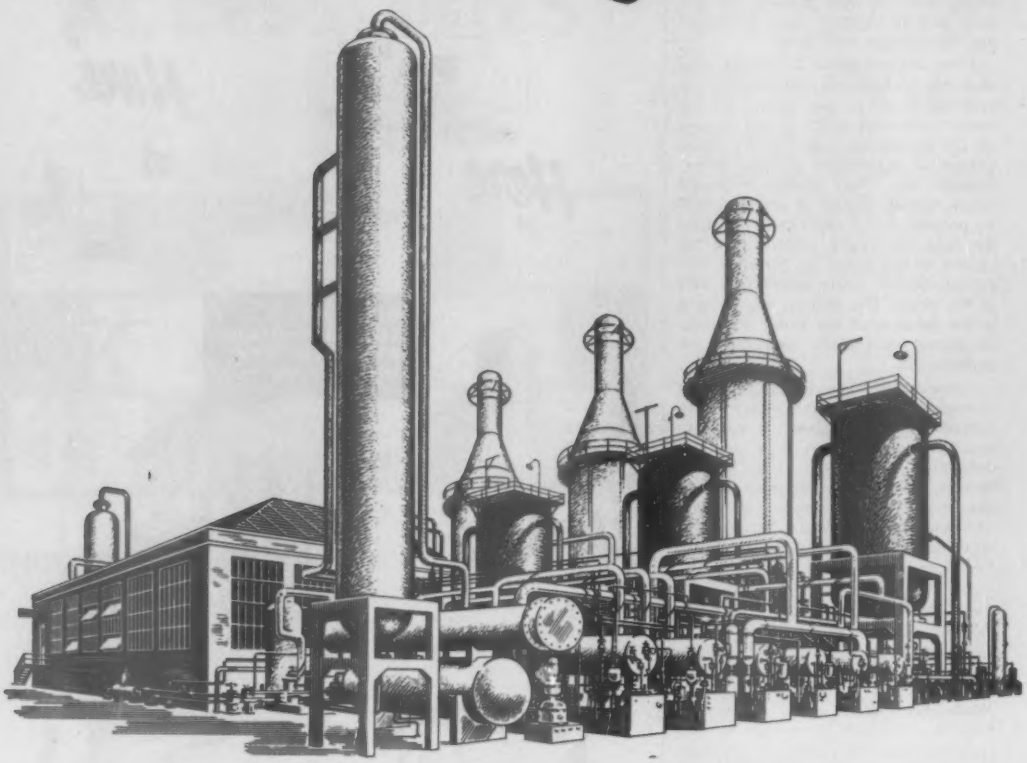

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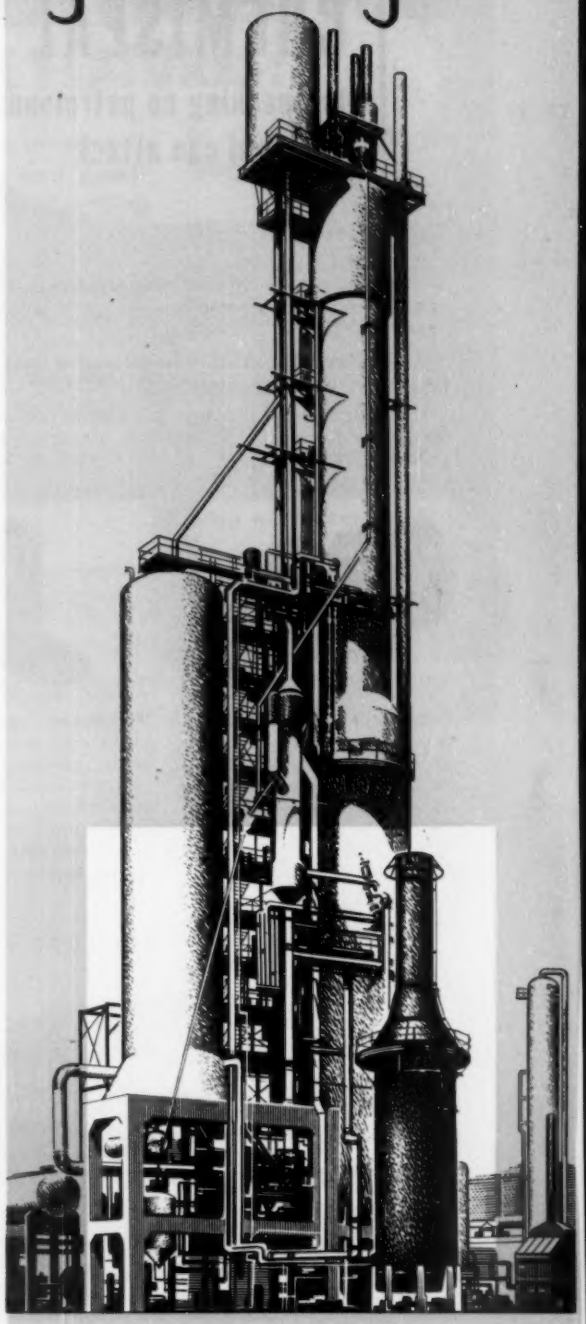

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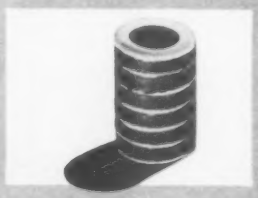

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stalled in bends. Where corrosiveness is present to a major degree, it may be necessary to face the entire line with a corrosion-erosion liner. In either case, supported castable as used elsewhere for erosion protection has been demonstrated to be very effective.

In the regenerator overhead line, water sprays usually are provided to reduce the flue-gas temperature if the waste-heat boiler is out of service for one reason or another. With these sprays in operation, erosion is apt to be rather severe in the line immediately downstream. The conventional supported castable liner has not stood up well under the effect of the water sprays. Certain acid-resisting cements have proved effective here, supported in the usual manner by hexagonal steel mesh. Chrome ore castables appear promising and will be tried in the future.

Protection from water spray impingement should extend from the first spray to about 15 to 20 ft. beyond the last spray. Since flue-gas lines usually are provided with a heat-insulating liner to reduce pipe-wall temperature, the installation of additional protection against erosion entails the consideration of thermal expansion effects. Fig. 7 indicates a type of shield which has proved satisfactory at this point.

### Water Sprays

Water sprays are provided in the regenerator shell to control temperature in the dilute phase above the catalyst bed. It is not always appreciated that these sprays induce a rather violent local recirculation of catalyst-laden gases which will seriously erode the regenerator lining and spray head unless certain precautions are employed.

To protect the sprays, it is desirable to position the head so that the issuing stream just clears the shroud pipe in which the spray is mounted. If the spray is located much beyond the inner wall of the vessel, erosion of the head will be greatly accelerated. In any case, the spray should be withdrawn for inspection at regular intervals. To protect the lining in the vicinity of the water sprays, a steel plate should be provided surrounding the shroud pipe. Recommended installation techniques are indicated by Fig. 8.

It is evident from the foregoing that the development of the supported castable wear plate or lining has been a major factor in reducing the cost of repairs due to erosion in fluid catalyst cracking plant equipment. While the supported castable should be considered primarily as an expendable member protecting the equipment surface on which it is installed, this does not

*(Continued on page 276)*

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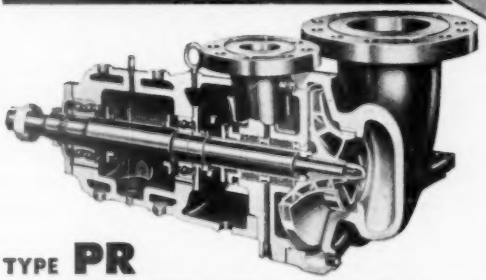

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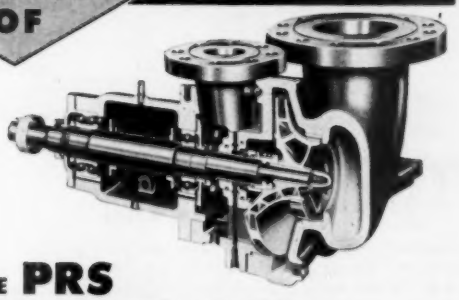

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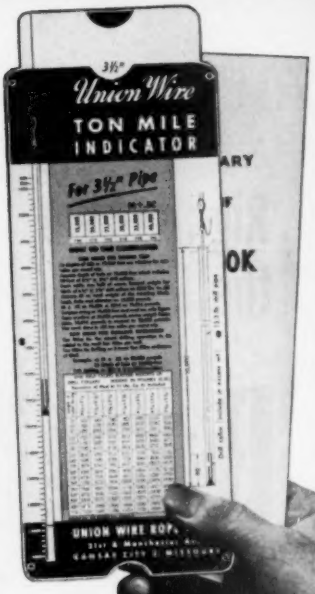


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imply that complete replacement is required following each run. Usually only minor sections are deteriorated. The supported castable has a tremendous advantage in this regard in that the damaged sections may be restored without affecting other uneroded sections.

**Liner repair . . .** If a section of the liner is to be repaired, it is necessary to remove all castable remaining in the mesh. The reason for this is that the castable must be locked securely in place by the steel mesh. If the liner is repaired merely by filling the voids with castable, the new material cannot be expected to remain in place. Fig. 2 illustrates the conditions which would be expected to follow rather quickly if this were done. In view of this, it is usually cheaper and quicker to rip out the deteriorated sections and replace completely with new materials.

Insofar as materials are concerned, there are many dense castable refractories available on the market today which give excellent service in resisting erosion. Nevertheless, interest continues in the possibility of determining even better materials and present-day development efforts are in this direction.

The most recent experience, while somewhat limited, indicates the chrome ore type refractories to exhibit remarkably good resistance to erosion. Various commercial installations are currently in service and others planned using this type of material at points of extreme erosion.

The chrome ore is available both for application by pneumatic gun and in plastic form for installation by ramming. It is yet to be determined whether there is any preference for one type of installation over the other.

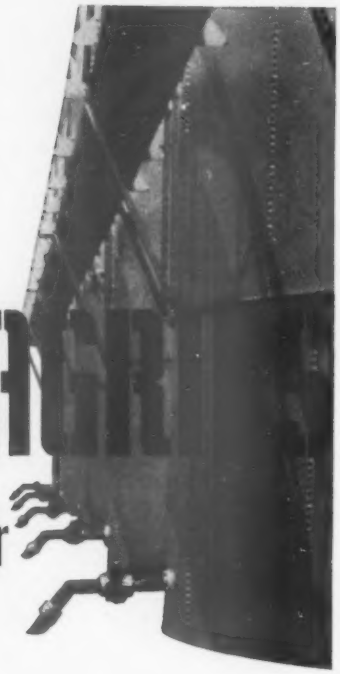
Certain maintenance items arising due to erosion are best handled by having spare parts at hand for replacement installation during the plant turnaround. The members removed are then serviced during the following run and made ready for reinstallation at the next shutdown. Slide-valve seats and slides and reactor grid sections are typical examples of such items.

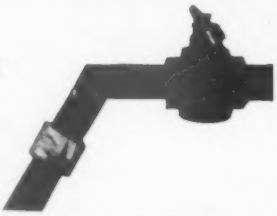
It is only by effective turnaround planning and detailed job organization beforehand that plant down time can be minimized. A significant factor in this connection is the accumulation of experience pointing to the nature and extent of repairs necessary after a run. Having this knowledge, repair materials may be accumulated and maintenance procedures planned well in advance of the shutdown. This is but one of many factors which contribute to realizing service factors of 96-98 per cent in fluid catalyst cracking plants.


Right down the line it's

ROLAGRIP

the coupling for plain end pipe





At this pipe line outlet, and in scores of drilling, producing, and refining installations, you'll find Rolagrip couplings for plain end pipe used throughout. Rolagrips are a "natural" for the petroleum industry — tight and leakproof . . . easy to put on and take off . . . flexible . . . automatically "cushioned" against end pull, vibration, shock, expansion and contraction.

And remember—no grooving, threading, flanging, or welding is necessary when you use Rolagrips. Try some from your favorite local supply store, where Rolagrips are available in sizes 1½" to 12". (If the job calls for grooved pipe, ask for Gruvagrip couplings and Gruvagrip fittings.)

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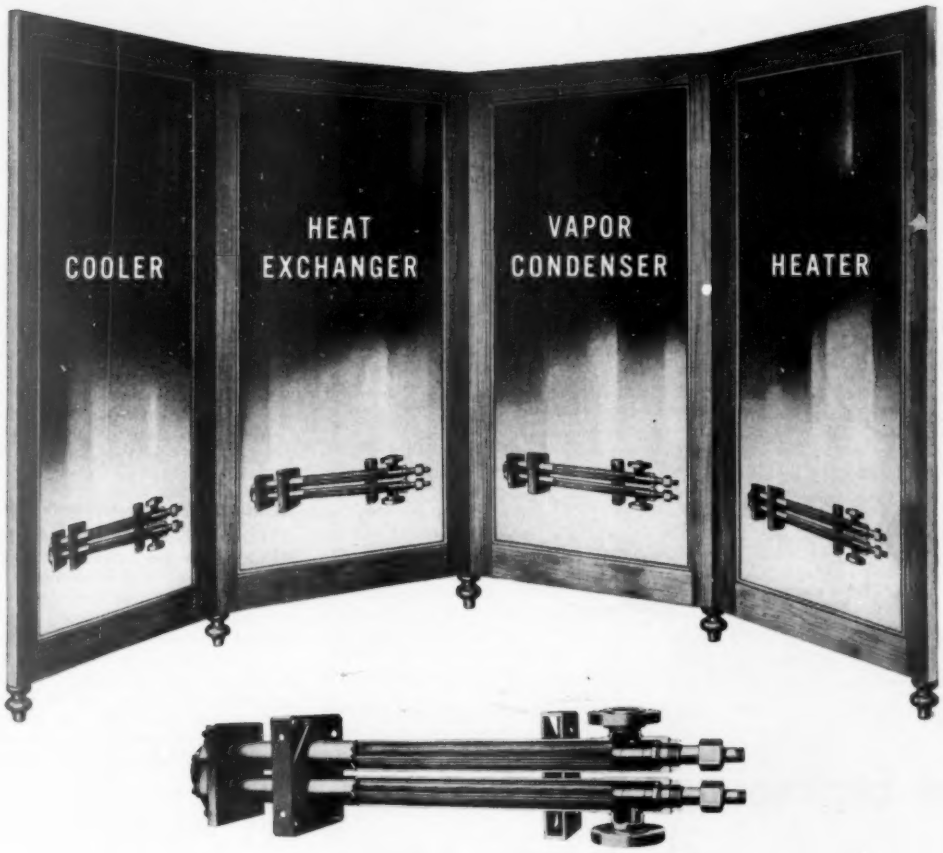


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More than 70,000 of these units have been installed since G-R originated the design over 20 years ago. And this unmatched record has conclusively proved the reliability, durability and low maintenance expense of Twin G-Fin Sections.

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**G-R** HEAT TRANSFER APPARATUS **Twin G-Fin Section**

GR-306

Here's how project activities revolve around the project engineer and his immediate assistants.

# The Engineering Contractor . . .

## . . . and how he functions in building the oil and gas processing industry

**by John C. Reidel**
Mid-Continent District Editor

THE burden of building the oil, gas, and petrochemical process facilities falls on some three dozen engineering construction companies in the United States. A number of these companies are also active on projects outside the United States. At one time or another these companies offer service in: (1) planning and evaluation, (2) economic studies, (3) research and development, (4) process creation and design, (5) engineering and drafting, (6) erection of equipment, and (7) operation of process units.

The primary function of the engineering contractor is to convert ideas and capital into process and equipment. It takes engineering know-how, an able and integrated working force, and the most modern construction methods and equipment to do the job right. The engineering contractor's contribution in these respects adds up to savings, in the long run, for the client.

### What Does It Take to Do the Job?

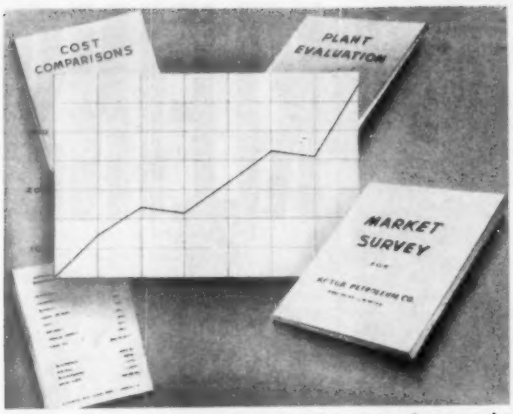
The conversion from ideas and capital to process and equipment must be made as rapidly as possible and at the lowest cost. This is an extremely difficult and complex task when a modern refinery construction job is considered.

Suppose that A B C Refining Co. decides to install a catalytic cracking unit. When the refiner asks for bids he automatically gets from the contractor preliminary process and mechanical design layouts and cost estimate of the job.

**Large items . . .** The contractor's specialists go to work to estimate the cost of the cat cracker. Vessel steel, structural steel, piping and fittings, foundations, electrical items, instruments—all of these must be figured. Man-hours of drafting, engineering, and erection labor must be included in the estimate.

## STARTING THE CAT CRACKER . . .

A detailed account of the engineering and construction of a process unit would require several volumes. This article describes in a general way what is involved in the design, purchasing, and erection of process units. For readers who are specialists in this type of work and for others who would like to learn more about it the first in a series of articles on Building Refinery Process Units appears elsewhere in this issue.




**Markets and economics are all important when a new plant or major addition is under consideration.**

THE CUSTOMER
DECISION TO BUILD OR ENLARGE FACILITIES
INFLUENCE & FINAL CONTROL OVER EQUIPMENT PURCHASES
APPROVAL OF PLANS AND ESTIMATES
ACCEPTANCE OF COMPLETED OPERATING PLANT
THE ENGINEER CONTRACTOR
ECONOMIC STUDY OF EXISTING OPERATION
DETAILED MECHANICAL DESIGN
PURCHASING EXPEDITING INSPECTION
PROCESS CONCEPTS TO MEET CONDITIONS REQUIRED
DETAILED PROCESS DESIGN
OPERATING PLANT DELIVERED TO MEET ALL SPECIFICATIONS
TRAINING OF PERMANENT CREWS FOR OPERATION
INSTALLATION AND CONSTRUCTION

**Different phases of a plant project and the client-contractor relationship are indicated here.**

What does it take to build a cat cracker? It is difficult to speak in terms of "averages" because conditions vary from job to job. However, to get an idea it may be stated that a large catalytic cracking job may require in round figures:

1,000 tons of steel plate for process vessels.

1,000 to 1,500 tons of structural steel.

3,000 to perhaps 3,500 tons of pipe and fittings.

6,000 to 7,000 cu. yd. of concrete.

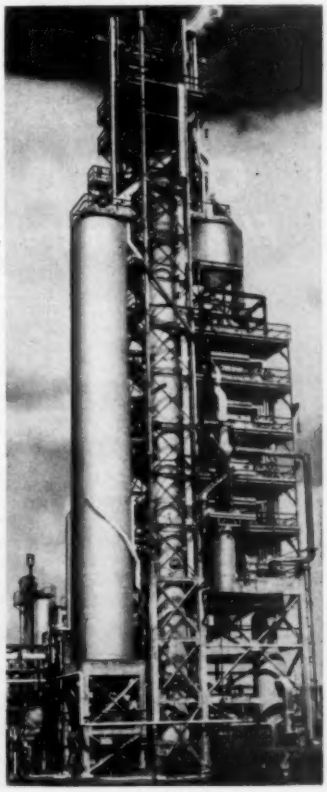
A rough figure for capital investment would be around $400 per barrel of throughput capacity. A cat cracking unit of say around 25,000-bbl. per day capacity would, therefore, cost in the neighborhood of $10,000,000.

**Small items . . .** But this is not the whole story. On the one hand the engineering contractor has to deal with the large items — foundations, large vessels, etc. On the other hand lies a sea of minutia. It is hard to convey in words or figures the many details that the engineering contractor must cope with in constructing a cat cracker, the many drafting hours that must be spent on piping details, the numerous problems that arise in specifying equipment and fabrication and the extremely close coordination and constant check and recheck of details that are required.

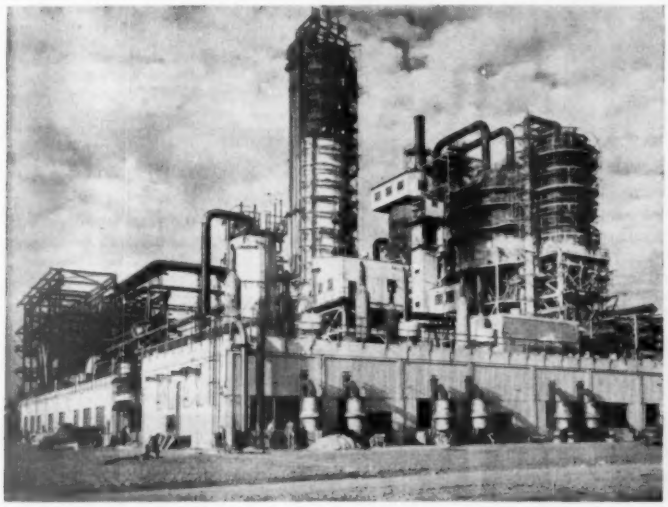
Moreover, it is not enough simply to build the plant in the shortest time and at the lowest cost. The process industries, as indeed any industry, operates competitively to get the greatest yield of high quality product at the lowest operating cost. The plant is built with that idea in mind.

For the refinery industry the engineering contractor is organized to:

## ON STREAM . . .



## NEARING END OF CONSTRUCTION . . .



HE PROBABLY THINKS SHE'S AS BEAUTIFUL AS AN ANSUL FIRE EXTINGUISHER..
..YEA..BUT HE'LL FIND SHE'S NOT NEARLY SO EASY TO HANDLE!
ANSUL
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SEE PAGE 402

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1. Analyze the client's requirements in the light of market conditions.
2. Make preliminary process design for alternate cases or conditions as dictated by experience.
3. Make detailed process design once limiting cases have been selected.
4. Conduct the necessary engineering and drafting.
5. Coordinate purchasing with engineering and drafting.
6. Carry out erection.
7. Train the client's operators and start up the completed plant.

Analysis of the client's requirements begins with consideration of the feed stock which is to be processed. This in turn depends on the characteristics of the refinery crude supply. One crude oil may yield greater percentages of gasoline than another. A different crude may have a suitable yield of "heart-cut" stock for lubricating-oil manufacture. Still another crude oil may have good possibilities for manufacture of asphaltic specialties. The customers markets are the all-important item. One client may go all out for gasoline manufacture. Another client may have a good market for burner oils and may be reluctant to disturb this market in favor of greater gasoline production.

**Preliminary design . . .** The contractor's experienced process design engineer can quickly determine which conditions of process flow, temperatures, pressures, and charging rates are applicable to the job at hand. Preliminary design then consists in preparing a process flow sheet on which major equipment is first sketched, then sizes determined, principal connecting lines drawn in, and auxiliary equipment added. Alternate cases are designed where different charge stocks may be changed, in anticipation of future conditions or with different arrangements of equipment. For example, substantial additional savings may be made in recovery of heat by one arrangement of heat exchangers over another.

After completing preliminary design, the process engineers proceed to the detailed design in which sizes of vessels, and piping are determined, and as much information developed as possible that will be of aid in engineering and drafting. All of this information ends up in a detailed process flow sheet.

**Process design data . . .** In conducting this phase of the work, the contractor's process engineers generally utilize considerable tabular and graphic design data. These include properties of petroleum fractions and petroleum hydrocarbons.


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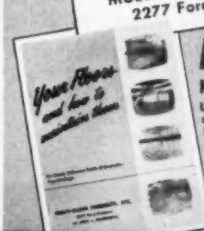


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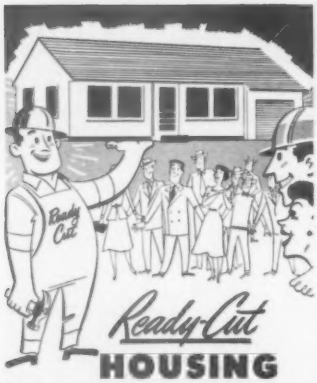


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Much information is also included in the contractor's process design data files on fluid flow, heat transfer, distillation, etc. In addition, there will be data on efficiencies of pumps and compressors, and on steam-turbine drives, and other similar information.

**Standards . . .** When design reaches the drafting and general engineering stage there are various standards which must be followed. These include pressure-vessel construction codes, piping codes, electrical codes, operating-company specifications, etc.

**Drafting . . .** Much time is required to train a force to function smoothly as a team. This is the reason why a strong effort is made to maintain a constant level of drafting and engineering personnel. About 50 per cent of total drafting time is taken up by piping details so that the rate at which design can proceed is dependent on getting the piping layouts under way promptly.

Equipment drawings are supplied to the piping group which makes an initial layout of major lines. When layout drawings for vessels and other items have been transmitted to the foundations group, design work can be started on foundation and electrical drafting can begin.

Throughout the drafting stage, drawings are continually checked and rechecked. Revisions and corrections are made, and new drawings are issued periodically. Personnel are kept fully informed concerning these revisions.

**Erection . . .** On a major project, field employes from the general superintendent through welders and to the clerks and timekeeper, move in on a project. Craft workers form the nucleus for expansion of the force as construction gets rolling. During erection, care is taken that best utilization of crafts is made in going from unit to unit so that workers are fully occupied at all times.

While erection is going on or even perhaps before, training of operators is begun. Many engineering contractors have experienced operating engineers fully capable and available for initial startup of plants and the training of client's personnel in such operation.

One of the contractor's responsibilities is to supply his client with the latest revised drawings of equipment. Operating and maintenance instructions are also supplied for each piece of equipment. In addition, the contractor may prepare one or more operating manuals which are used as a training aid for operators. Such a manual will have a description of the process flow, equipment, and will include appropriate flow-sheet and equipment drawings. The contractor usually prepares a project book for the client's management and engineering staff.

**Function of Engineering Contractor**

Some idea has been given here of what it takes to do the job and how the job is done. It would not be feasible for most operating companies to undertake a job of this magnitude. As a rule they do not have the staff nor the time for it. Even in cases of a major operating company with its own complete engineering staff and specialized departments it is definitely advantageous to call in the contractor.

The contractor brings a fresh approach to the job.

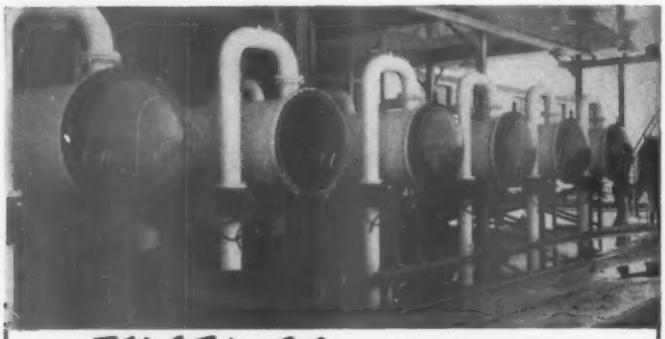
There is a pooling of talents.

There is a check on the operating company's cost estimating.

Purchases and delivery may be expedited.

Savings through use of the contractor's construction tools and methods are possible.

The engineering contractor with wide experience in all types of work and continuous movement from job to job is familiar with new ideas and new techniques and brings an objective viewpoint to the job. The large operat-

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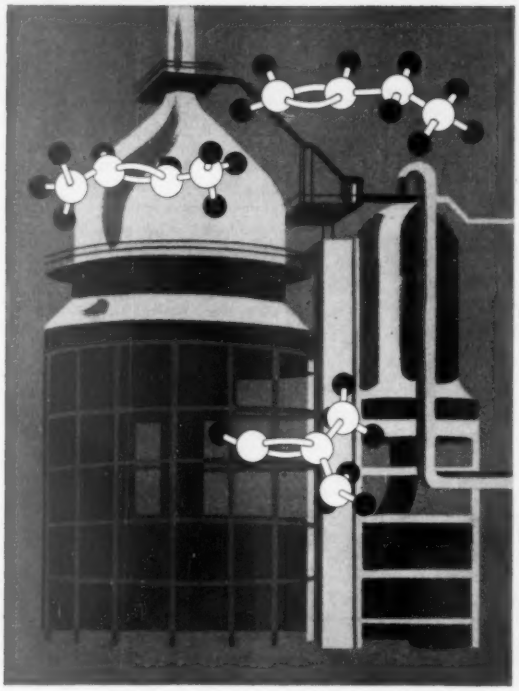

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CATALYSTS AND ADSORBENTS

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ing companies have found it to their advantage to work with the contractor and have benefited from an exchange of ideas.

**Costimating . . .** Again, despite efforts to keep them up to date the refinery cost records may get out of date. A unit is built and it runs for 5 or 10 years before another one is built. There is maintenance on the unit, and a certain amount of cost accounting may be done in connection with maintenance. The refiner is often surprised to find what a unit costs today as compared to what it cost 10 years ago. The operating company often underestimates the cost of its construction contingencies. There have been cases where contingencies were figured as 18 per cent of total costs, when actually they were 25 per cent and sometimes even higher. This has been particularly true under current economic conditions of inflation when costs have been going up so rapidly.

**What Is an Engineering Contractor?**

Engineering construction companies in the process industries offer services for design, construction, or revamping of refineries, chemical plants, and gas-processing plants. Activities may actually embrace a rather wide field, including construction of power plants, pipe-line compressor stations and pipeline work, and various oil and gas field processing installations, such as sulfur-recovery units and gas-treating installations.

Relatively few contracting companies do erection only. Most of them provide engineering and design services. In a recent Journal survey of companies it was found that:

1. Of those servicing the refining and petrochemical industries 22 companies do major process work, as well as mechanical design and erection.

Six companies do major process or mechanical design only.

Three companies do minor design and erection.

Three companies do erection only.

2. Of those serving the natural-gasoline or gas-processing industries 22 companies do major process and mechanical design and erection.

Four companies do major process and mechanical design only.

Two companies do erection only.

3. Of those engineering-contracting firms 27 also serve the pipe-line industry with engineering and installation of gas desulfurization and dehydration plants and pump or compressor stations.

**What Does the Engineering Contractor Offer?**

It has been noted that in particular the contractor offers two valuable services: engineering know-how and efficient methods.

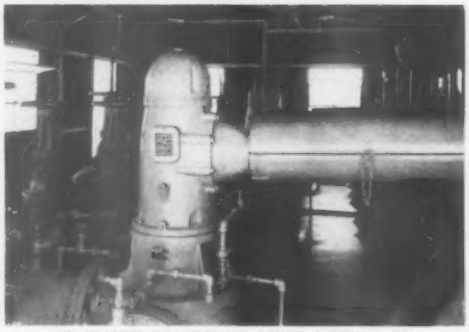
Some of the contractors maintain research and development facilities for making full evaluations from raw material to finished products for the oil, gas - gasoline, and petrochemical industries.

**Research and manufacture . . .** One engineering contractor, for example, has a portable pilot plant and adjunctive facilities for testing of natural gases to determine liquid product yields, product quality and operating conditions. An engineering and service group is maintained for consultation on design, construction, and operation of plants. Studies made by this group have contributed much toward greater safety and more experienced maintenance of gas processing plants.

**The talent pool . . .** One of the most important things the engineering contractor has to offer is its technical-talent pool. All branches of engineering—chemical mechanical, electrical,

*(Continued on page 309)*


**Amarillo Right Angle Turbine Pump Drive!**



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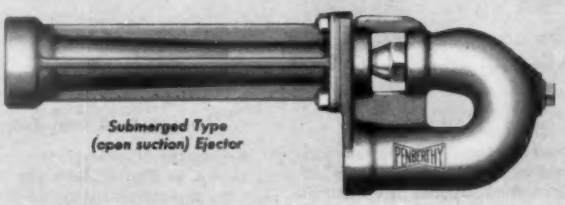

*Submerged Type (open suction) Ejector*

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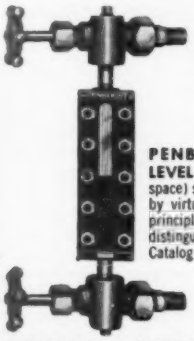

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•

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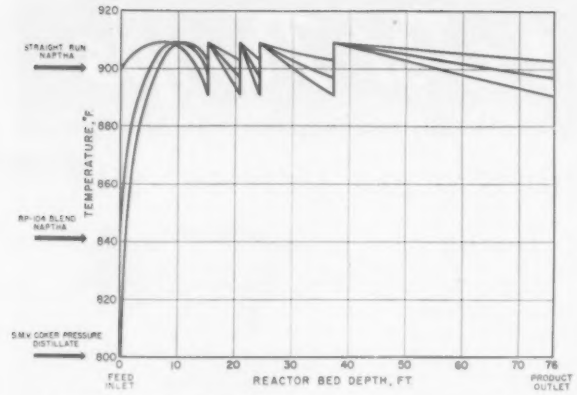
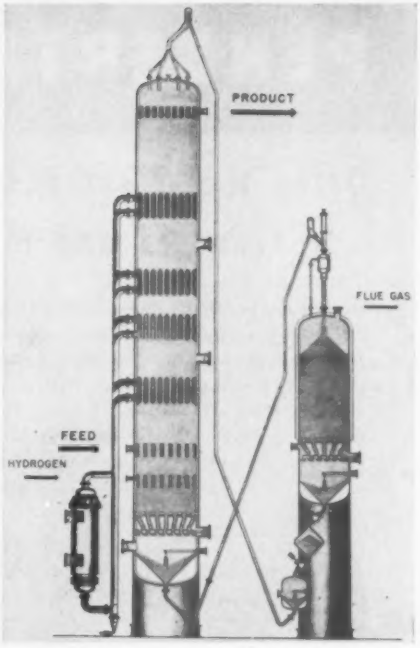



**TEMPERATURE PROFILES** in the Hyperforming reactor. **Fig. 1.**

# HYPERFORMING

## . . . makes its bow




**REACTOR AND REGENERATOR** utilize moving beds in Hyperforming process. **Fig. 2.**

Here is another process adapted to upgrade straight-run naphthas and other low-octane gasoline stocks.

**by Clyde Berg***

THE Hyperforming process carries out a continuous reforming and upgrading operation on gasoline stocks of low octane. In handling straightrun stocks, substantial quantities of hydrogen are produced, and cracked stocks can be processed when blended with straightrun without the requirement of external hydrogen for upgrading.

Operating pressure is near 400 psi. A recycle stream of hydrogen is employed in carrying out the catalytic reactions. Reactor temperatures are in the range of 800°-900° F.

External interheaters are incorporated on the catalytic reactor which provide precise control of temperature profile in the course of processing and provide the needed flexibility to handle both straightrun and cracked stocks in a single unit.

**Basic operation . . .** In Fig. 1 is given the Hyperformer reactor temperature profile typical of operation as it would exist on three different types of stocks:

1. Straightrun naphtha.
2. Blended naphtha and cracked stocks.
3. Cracked naphtha alone.

In operation on a straightrun stock, the feed is introduced near 900° F. Initially, a small amount of exothermic hydrocracking raises the temperature about 10° after which the endothermic aromatic formation causes about a 20° F. drop before the first interheater reheats the reactor vapors about 20°.

Following this aromatic formation this again causes a gradual drop in reactor temperatures and three successive interheaters maintain the temperature in the neighborhood of 900° F. It is apparent from the diagram that the same construction and location of interheaters provides the flexibility to handle cracked stocks and blends of cracked and straightrun stocks.

Circulation of catalyst in the Hyperforming unit is extremely low. Less than 5 tons per hour of catalyst will be circulated in a typical Hyperforming plant processing 10,000 bbl. per day of straightrun. This low catalyst circulation combined with extremely low attrition effects provided by the use of the Hyperflow conveying principle assures minimum over-all costs in catalyst makeup.

### Over-all Plant Operation

A diagram of a Hyperforming unit is shown in Fig. 2. Both the reactor and the regenerator utilize moving beds with Hyperflow conveyance of the solids between the major process vessels in a continuous cycle. By the use of continuous reaction and regeneration in this process, a substantial economy in plant construtions is effected and plant maintenance is reduced over that of cyclic processes.

The feed is introduced near the bottom of the reactor, moves upward countercurrent to the catalyst progressively through four interheating stages. It is produced at the top of the reactor as a thoroughly refined product.

Regenerated catalyst is collected at the bottom of the regenerator and transferred to the top of the reactor. Retained hydrocarbons on the spent catalyst are stripped and partially hydrogenated at the base of the reactor by a hydrogen stream introduced below the feed entrance point. Regeneration of the catalyst is carried out in a continuous moving bed employing a recycle of flue gas with an oxygen content below 2 per cent.

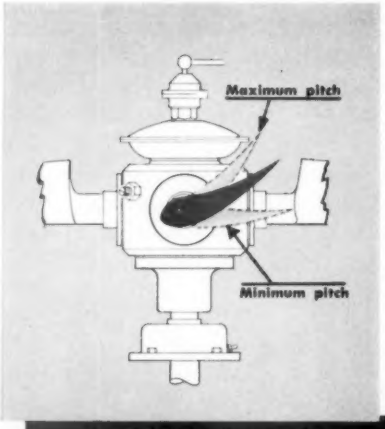
*Union Oil Co. of California, Los Angeles.

# *Another* NEW DEVELOPMENT *by* HUDSON

## HUDSON *Auto-variable* PITCH FAN

* patents pending

The Hudson Auto-variable pitch fan allows *automatic* control of cooler outlet temperature, regardless of air temperature, cooler inlet temperature, or heat load. Minute changes in cooler outlet temperatures immediately and automatically change pitch of fan blades increasing or decreasing the air flow across the coolers. This device marks an important advance in use of air for cooling—saving power, eliminating shutters, and smoothing process operations. Auto-variable fans will find wide application in cooling of jacket water and condensing hydrocarbon vapors and steam.



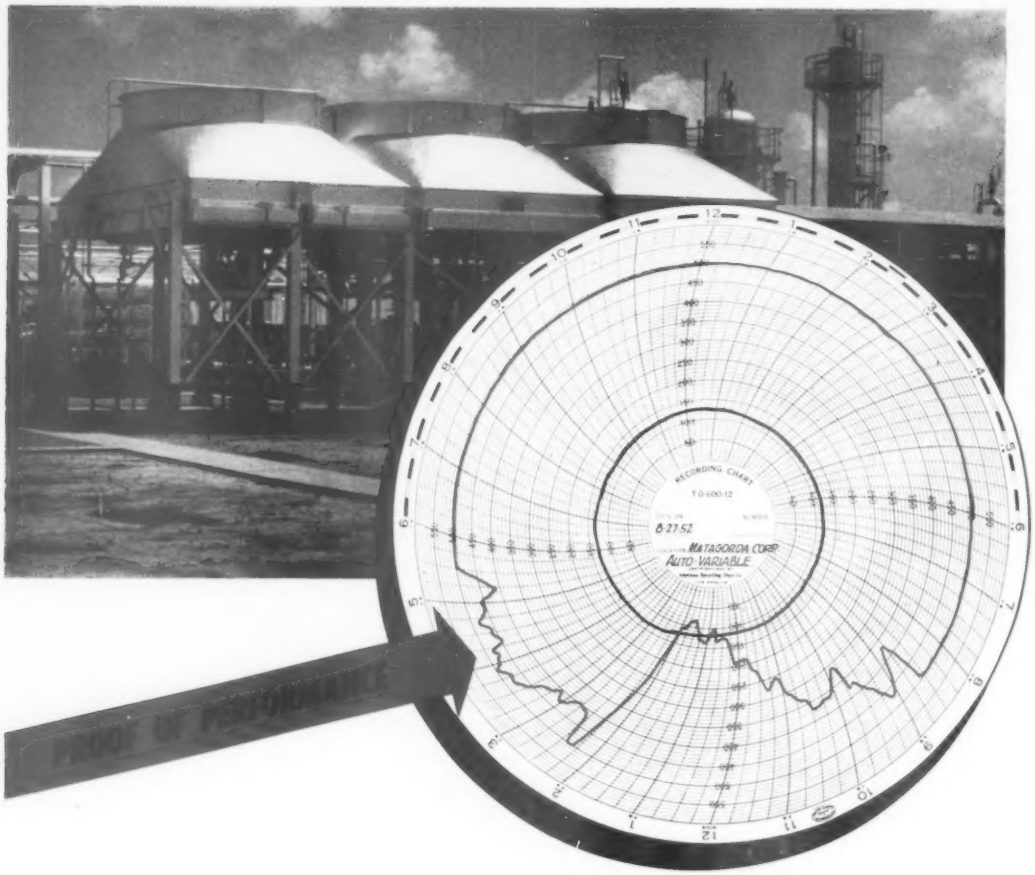

Fan pitch limit adjustment shown from maximum to minimum.

**The HUDSON Auto-variable pitch fan . . .**

- **Controls temperature.**
- **Saves power.**
- **Reduces cost of control equipment.**
- **Prevents freezing due to cold weather.**
- **Eliminates by-pass piping.**
- **Operates with standard pneumatic instruments on 0-15# air pressure.**

Hudson Auto-variable fans are available in sizes from 6 to 18 foot diameter for use in Hudson Solo-aire air cooled units and in Hudson Combin-aire units.

***PROOF OF PERFORMANCE*** ➡



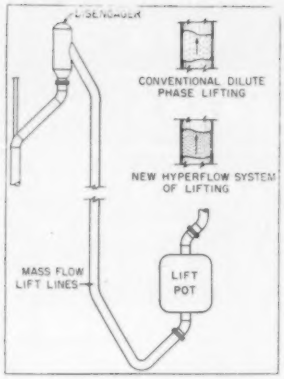

**70 PERCENT SAVING IN POWER**

***During the 24 hour period the measured electric power consumption was 30% of that which would have been required had the blade pitch been at a constant maximum.***

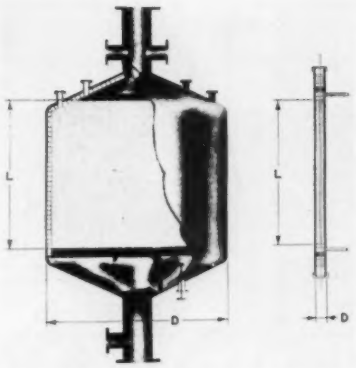
Shown above is a facsimile of a chart taken from a recording instrument used in controlling temperature on a Solo-aire gasoline condenser installed in Matagorda Corporation plant near Bay City, Texas. The outer line (red) shows the fan pitch variation required to maintain constant stream temperature (black line).

Despite air temperature variation from 72°F to 100° F, and despite changes in the heat load, the outlet temperature from the cooler was held constant throughout the 24 hour period.

**HUDSON**
**ENGINEERING CORPORATION**
**FAIRVIEW STATION • HOUSTON, TEXAS**




**GENERAL PRINCIPLE of Hyperflow. Fig. 3.**




**HYPERFLOW REACTOR is squat, large-diameter vessel. Fig. 4.**

This combination of a moving bed in the regenerator together with controlled oxygen content in the recycled flue gas limits the peak temperature rise and provides very precise control with the assurance of moderate temperatures in the removal of coke from the catalyst.

Elutriation of fines is effected at the entrance of the regenerator from the entire circulated catalyst stream. Catalyst is transferred from the regeneration vessel at the base of the lift line through a simple lock system and conveyed by Hyperflow to the top of the Hyperformer reactor.

**Catalyst conveyance . . .** The Hyperflow lift line principle was recently developed by Union Oil Co. and is utilized to move the catalyst at very low velocities and at minimum attrition loss. The general principle of Hyperflow is illustrated in Fig. 3. Solids are conveyed in compact unfluidized mass.

Density of the flowing stream is substantially the same as a compact downward moving solids bed. It employs low gas and solids velocity. Rather high pressure differentials are required but small quantities of lift gas are employed. This technique of solids handling was developed after many years of study and experience in the handling of solids in the Hypersorption process. It combines the following advantages:

1. Minimum breakage of solids.
2. High rates of solids transport in small-size equipment.
3. Inexpensive to build and install.
4. Low maintenance and operation costs.
5. Readily adapted to high temperature and pressure conditions.

This means of solids circulation has already been extensively tested under a wide variety of operating conditions including extremes of temperature and pressure as well as high rates of solids conveyance. The Hyperflow conveying method in addition provides the important process function of establishing a posiltive seal between the two reaction vessels preventing the escape of combustible materials.

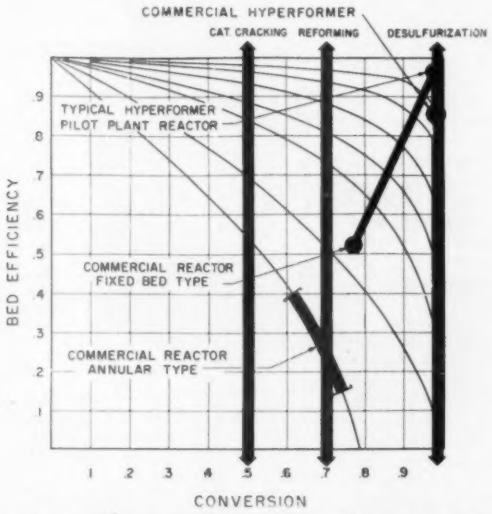
**Catalyst proved . . .** To meet the requirements of general-purpose reforming and upgrading operations, it is necessary that the process be capable of handling the full range of naphtha stocks which a refinery may find desirable to reform. In this regard it is highly important that an occasional contamination of stocks not cause serious complications in plant operation.

The ability to refine both straight-run and high-sulfur stocks of all varieties of inferor crudes without deleterious effects or catalyst poison is well established insofar as the cobalt molybdate catalyst is concerned.[1 2 3]

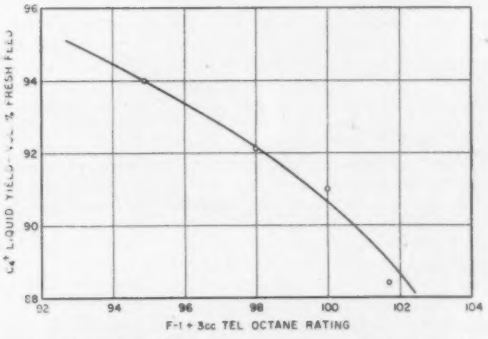
**Hydrogen economy . . .** In operating a reforming unit for the upgrading of cracking stocks blended with straight-run, hydrogen economy is an important consideration. When utilizing an oxide-type catalyst, such as cobalt molybdate, it is important that catalyst circulation be held at a minimum.

This factor is more important with mixed stocks than with straightrun stocks alone.

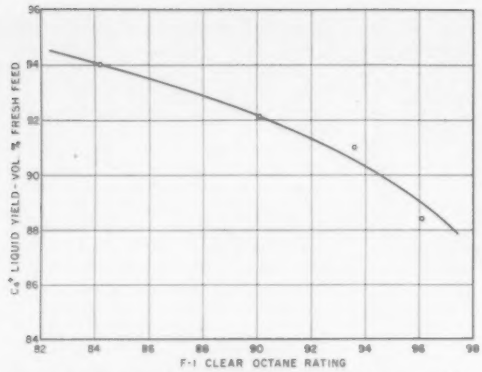
Coke laydown on the reforming catalyst is minimized by increased partial pressure of hydrogen. Careful consideration in the Hyperforming process development have led to selection of pressures on the order of 400 psi. as



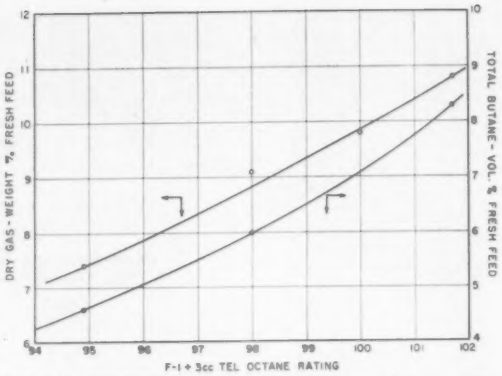

**GENERALIZED CORRELATION for conversion and bed efficiency in the Hyperflow process design calculations. Fig. 5.**



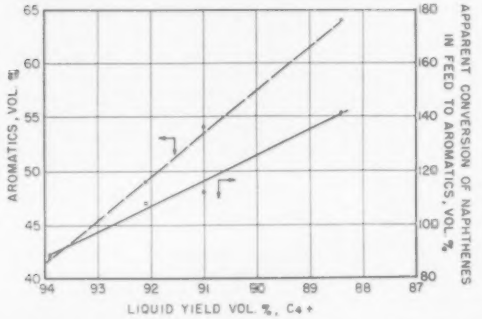

**YIELD-OCTANE CURVE in Hyperforming straightrun naphtha. Yield is based on F-1 plus 3 cc. TEL. Fig. 6.**




**YIELD-OCTANE CURVE in Hyperforming straightrun naphtha. Yield is based on F-1 clear octane. Fig. 7.**




**DRY GAS AND BUTANE yields in Hyperforming straightrun naphtha. Yield is based on F-1 plus 3 cc. TEL. Fig. 8.**




**AROMATIC PRODUCTION in Hyperforming straightrun naphtha. Fig. 9.**

optimum for minimum coke laydown in relation to other process variables.

### Reactor Design

The use of an integrated tower construction for the reactor provides the compactness necessary for good engineering design and economy in construction. The use of external heat exchangers for maintenance of the optimum temperature profile provides precise control over this variable with use of conventional equipment with full flexibility to run a wide range of stocks since the external heat exchangers are capable of operation either to add or remove heat from the reaction stream.

Of considerable importance is the fact that this means of temperature control in the reactor does not involve other process variables and lead to complications requiring a compromise on fundamental aspects, such as catalyst circulation, attrition loss, and the like.

In every catalytic reactor there is a possibility of bypassing the fresh or partially converted feed past sections of the catalyst bed.[4] This probability is increased as ratio of diameter to length of the bed is decreased.

A large-diameter squat reactor, such as that shown in Fig. 4, leads to greater possibility of bypassing of the feed than that of a narrow, slender reactor which might be used in pilot-plant studies. Even more severe bypassing would be expected from designs which incorporate radial flow through the catalyst bed by introduction through a pipe-like manifold in the center with collection in an outer annular space. These effects would be equally pronounced in a fluidized reactor where extensive top to bottom mixing occurs throughout.

Based on extensive studies, the requirements for commercial-plant reactor performance can be correlated quite accurately by recognized probability methods. The efficiency of a catalytic reactor is related to two factors: (1) that of the conversion level at which the reactor must be operated and (2) the length to diameter of the reactor which determines the effective number of stages of contact.

**Design correlations . . .** In Fig. 5 is presented a generalized correlation of these relationships for reactor design. It will be noted that conventional system cracking operations are only mildly affected by the number of contact stages available since conversions on the order of only 50 per cent are generally involved. In the case of straightrun gasoline, reforming conversion approaches 70 per cent but still is not critical as regards the number of stages in the catalytic reactor.

In the case of upgrading cracked stocks and high-sulfur stocks, conversions approaching 98-99 per cent must be attained in the elimination of undesirable constituents. Here the number of stages available for contacting becomes indeed critical and the utmost care must be utilized in reactor design. Commercial Hyperformer reactors are able to provide a thoroughly desulfurized refined reformate from inferior stocks as well as upgrade the more conventional straightrun stocks to high-octane levels.

An important consideration in the selection of interstage external interheater construction for catalytic reactor design is the elimination of high transfer line temperatures. The heat requirements that compensate for the endothermic effects of aromatization

**TABLE 1—CHARACTERISTICS OF FEED STOCK USED IN PILOT-PLANT RUNS**

| | |
|---|---|
| Gravity, °A.P.I. | 51.8 |
| Engler distillation, °F.: | |
| Initial | 256 |
| 10 | 270 |
| 20 | 274 |
| 30 | 280 |
| 40 | 286 |
| 50 | 292 |
| 60 | 300 |
| 70 | 311 |
| 80 | 321 |
| 90 | 340 |
| 95 | 354 |
| Maximum | 382 |
| Per cent recovery | 98.5 |
| Sulfur, weight per cent | 0.05 |
| Nitrogen, weight per cent | 0.01 |
| Octane rating: | |
| F-1 Clear | 40 |
| F-1 + 3 cc. TEL | 63 |
| F-2 Clear | 40 |
| F-2 + 3 cc. TEL | 62.5 |
| Hydrocarbon analysis: | |
| Paraffins | 53 |
| Olefins | 1 |
| Naphthenes | 27 |
| Aromatics | 19 |

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NO GREASE

NO GRIME

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ANOTHER *Electric Power* CASE HISTORY

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TABLE 2—INSPECTION OF PRODUCT FROM PILOT HYPERFORMER

| | Run A | Run B | Run C | Run D |
|---|---|---|---|---|
| Liquid yield, volume per cent, $C_4$+ | 93.9 | 92.1 | 91.0 | 88.4 |
| Octane rating, $C_4$+: | | | | |
| F-1 Clear | 84.2 | 90.1 | 93.6 | 96.1 |
| F-1 + 3 cc. TEL | 94.9 | 98.0 | 100.0 | 101.7 |
| F-2 Clear | 75.2 | 79.4 | 83.5 | 86.7 |
| F-2 + 3 cc. TEL | 85.8 | 87.5 | 91.0 | 92.2 |
| Dry gas, S.C.F./bbl., feed | 300 | 391 | 396 | 423 |
| Butanes, volume per cent feed | 4.6 | 6.0 | | 8.3 |
| Gravity, °A.P.I., $C_4$+ | 52.2 | 52.4 | 53.3 | 52.8 |
| Engler, °F.: | | | | |
| 10 per cent | 209 | 175 | 163 | 158 |
| 50 per cent | 280 | 275 | 271 | 270 |
| 90 per cent | 335 | 346 | 347 | 349 |
| Hydrocarbon analysis: | | | | |
| Paraffins | 58 | 51 | 46 | 36 |
| Naphthenes | 0 | 0 | 0 | 0 |
| Aromatics | 42 | 49 | 54 | 64 |
| Apparent conversion of naphthenes in feed to aromatics, volume per cent | 89 | 108 | 111 | 141 |

are provided by the interheaters without the necessity for high inlet temperatures.

### Refining of Straightrun Gasoline

In Tables 1 and 2 are given the inspections of a Mid-Continent straightrun gasoline and the products obtained in Hyperforming at various levels of severity.

It will be noted that this feed stock has an F-1 clear octane rating of 40 and reforming operations were readily performed at a level of 95 to 100 F-1 + 3 cc. TEL. The hydrocarbon distribution presented in this table shows that the paraffin content of 53 per cent is somewhat higher than the average Mid-Continent stock.

In these reforming studies the octane level of the product has a range from 95 to 101.7 with liquid yield of $C_4$ and heavier ranging from 93.9 to 88.4. It will be noted that even at 100 octane, F-1 + 3 cc. TEL, $C_4$ and heavier liquid yield is about 91 per cent.

In Fig. 6 is presented the yield octane curve of $C_4$ and heavier product plotted against the octane rating of F-1 + 3 cc. TEL.

In Fig. 7 is presented the yield octane curve of $C_4$ and heavier product plotted against the F-1 clear octane rating. Even at high-octane levels, the over-all liquid yield is not dropped seriously from the level obtained under more moderate conditions.

In Fig. 8 is presented a plot of the dry gas and butane production as a function of the F-1 clear octane rating of $C_3$ and heavier product.

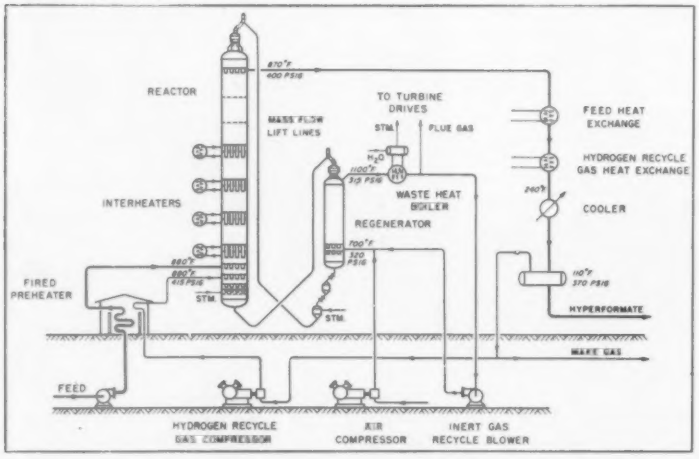
**Aromatic production . . .** Examination of the data in Table 2 shows aromatic content of the hyperformate product reaching a level of 64 per cent with an over-all liquid yield of 88.4. Particularly notable is the fact that substantial cyclization of paraffins in the feed is effected at the higher levels of reforming and that in Run D the product contains 41 per cent more aromatics than can be attributed to dehydrogenation of the naphthenes in the feed.

This characteristic in Hyperforming permits the production of high-octane gasoline from stocks containing low naphthene content. It is also valuable in reforming operations carried out specifically for the production of aromatics for chemical use.

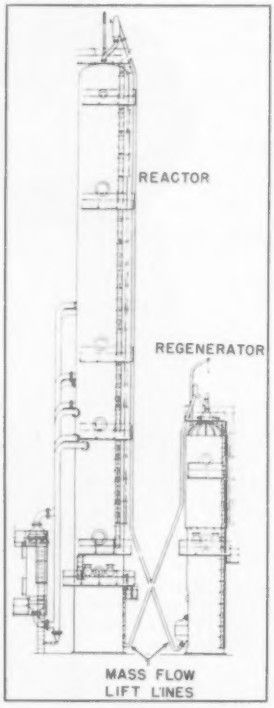
In Fig. 9 is plotted the apparent conversion of naphthenes to aromatics and the aromatic production as a function of liquid yield.

**Commercial design . . .** In Fig. 10 is presented a process flow sheet of a Hyperforming plant set up for processing straightrun stocks. In Fig. 11 is presented construction detail for this plant. In Tables 3 and 4 are presented the material balance, product distribution, and utility requirements for a typical plant operating on 10,000 bbl. per day of straightrun stock.

Over-all utility requirements are relatively low in this plant in the processing of straightrun stocks. This is at-




FLOW SHEET for Hyperforming plant set up for processing straightrun stocks. Fig. 10.




CONSTRUCTION DETAIL for straightrun process. Fig. 11.

**TABLE 3—MATERIAL BALANCE AND PRODUCT DISTRIBUTION FOR 10,000 BBL. PER STREAM DAY STRAIGHTRUN HYPERFORMER**

| | Bbl./SD | M.S.C.F./D | °A.P.I. | M.W. | Lb./hour | Liquid yield, vol. per cent |
|---|---|---|---|---|---|---|
| Feed: | | | | | | |
| Naphtha | 10,000 | .... | 51.6 | .... | ..... | 100 |
| Products: | | | | | | |
| Light gasoline | 7,500 | .... | 60.0 | .... | 80,790 | 75.0 |
| Heavy gasoline | 1,890 | .... | 36.0 | .... | 23,670 | 18.9 |
| Dry gas | .... | 2,502 | .... | 27.4 | 7,500 | .... |
| Hydrogen | .... | 2,400 | .... | 2.0 | 540 | .... |
| | | | | | 112,500 | 93.9 |

**TABLE 4—UTILITY REQUIREMENTS FOR 10,000 BBL. PER STREAM DAY STRAIGHTRUN HYPERFORMER**

| | |
|---|---|
| 1. Fuel gas for fired heaters, etc., M.M.B.t.u./hour | 77.8 |
| 2. Steam: | |
| Generated by regeneration waste heat boiler (400 psig.), lb./hour | 3,920 |
| Recovered lift line steam, 400 psig., lb./hour | 2,550 |
| Total plant prod., 400 psig., lb./hour | 6,470 |
| Net steam production, 400 psig., lb./hour | 600 |
| 3. Cooling water circulation rate, g.p.m. | 3,292 |
| 4. Electricity for lighting and instruments, kw. | 50 |

tained by the fact that the plant is operated at conditions which minimize coke laydown and the equipment required to regenerate the catalyst. Because of the minimum coke laydown effect, very low catalyst circulation is required. Hydrogen recycle required by the process is on the order of 3,000 standard cubic feet per barrel and at the pressure level of 400 psi. Power requirements for this circulation are moderate.

### Processing of High-Sulfur Stocks

Blends of high-sulfur gasoline can be processed in the Hyperforming process and the cracked stocks can include those which require extensive upgrading, such as high sulfur-high nitrogen-containing stocks from inferior crudes. With the addition of outside hydrogen, gasoline stocks containing as much as 3½ per cent sulfur have been refined.

By blending straightrun with the inferior stock, it has been found possible to refine these high-sulfur stocks without the requirement of external hydrogen generation. This is a major advancement in refining technique and is of particular interest to refiners who must process inferior crudes.

This technique utilizes the hydrogen released in the dehydrogenation of naphthenes to aromatics to simultaneously eliminate large quantities of sulfur, nitrogen, and oxygen in inferior stocks. Olefins are saturated as well. The various characteristic reactions proceeding in the reactor are outlined in Fig. 12. This sufficient exchange of

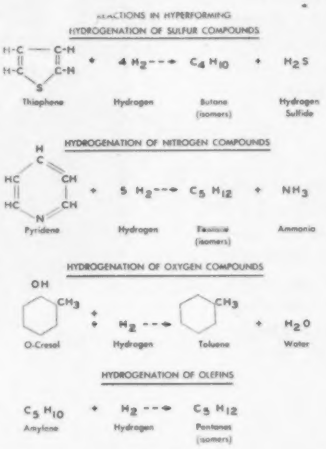



**Fig. 12.**

hydrogen between the straightrun gasoline and the inferior stock leads to refined gasoline of excellent quality.

In Table 5 is presented the over-all material balance of the products that would be derived from processing 10,000 bbl. per day of a blend of 70 per cent Santa Maria coker gasoline and 30 per cent straightrun stock. By this operation approximately a 2 per cent gasoline blend would be refined to less than 0.1 per cent sulfur and the product upgraded to an octane level of 95 F-1 + 3 cc. TEL.

**Volatility and general upgrading improvement . . .** The Hyperforming Process possesses ability to produce large quantities of light gasoline by controlled selective hydrocracking of the feed which progresses under reactor conditions. Table 6 shows the inspection of the feed and product in the refining of high sulfur Santa Maria gasoline from coker operations. It will be noted that there is a 60° F. drop in midpoint boiling range of the gasoline stock which substantially increases the volatility necessary for good performance in automotive engines.

This characteristic is of value to the refiner in the production of premium gasoline stocks as well as aviation blending stocks.

**TABLE 5—MATERIAL BALANCE AND PRODUCT DISTRIBUTION IN PROCESSING 10,000 BBL. PER STREAM DAY OF BLENDED 70 PER CENT SANTA MARIA CRACKED GASOLINE AND 30 PER CENT STRAIGHTRUN NAPHTHA**

| | Bbl./SD | M.S.C.F./D | °A.P.I. | M.W. | Lb./hour | Liquid yield, vol. per cent |
|---|---|---|---|---|---|---|
| Feed: | | | | | | |
| Naphtha | 10,000 | .... | 50.3 | .... | 113,500 | 100 |
| Products: | | | | | | |
| Light gasoline | 8,140 | .... | 63.6 | .... | 86,010 | 81.30 |
| Heavy gasoline | 1,345 | .... | 36.3 | .... | 16,510 | 13.44 |
| Dry gas | .... | 2,415 | .... | 30 8 | 8,170 | ..... |
| Coke | .... | .... | .... | .... | 819 | ..... |
| $H_2S$ and $NH_3$ | .... | .... | .... | .... | 2,040 | ..... |
| | | | | | 113,500 | 94.74 |

**TABLE 6—INSPECTIONS OF FEED AND PRODUCTS OBTAINED BY HYPERFORMING OF SANTA MARIA LIGHT COKER DISTILLATE**

| | Feed | Product |
|---|---|---|
| Gravity, °A.P.I. | 52.7 | 60.0 |
| Engler distillation, °F.: | | |
| Initial | 147 | 87 |
| 10 per cent | 192 | 131 |
| 50 per cent | 267 | 205 |
| 90 per cent | 342 | 328 |
| 95 per cent | 364 | 415 |
| Maximum | 390 | 429 |
| Sulfur, weight per cent | 3.47 | 0.035 |
| Nitrogen, weight per cent | 0.020 | 0.002 |
| Octane rating, F-1 + 3 cc. TEL | 80.0 | 94.5 |


### Acknowledgment

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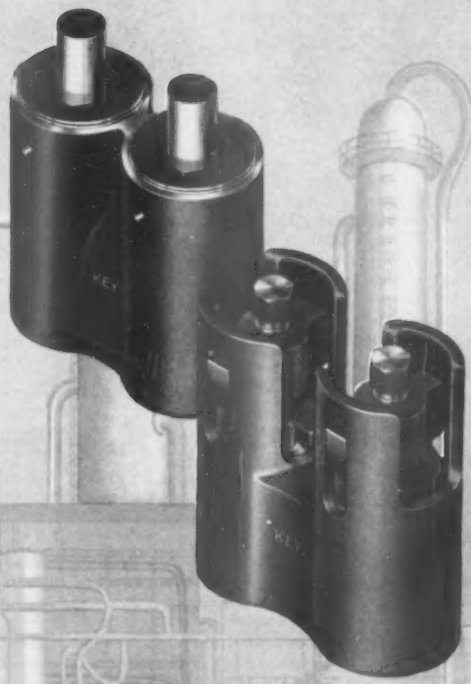


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In the view at left, the large sloping pipe is a seal leg. Catalyst beads in a packed bed flow through it from gas lift (vertical pipes inside structure) to reactor below. As seen in view above, Geiger counters are mounted in a ring at each end of the upper seal leg. Connected through a preamplifier to a meter in the control room, they signal the passage of radioactive beads at these points.

## *New Use for Radioactive Tracers . . .*

# Measuring Catalyst Flow Rates in Cat Crackers

**Method involves measurement of time interval required for radioactive bead to pass between two points such that intervening weight of catalyst is accurately defined**

**by D. E. Hull* and R. R. Bowles***

RADIOACTIVITY has been adapted to another important application in the petroleum industry—the measurement of catalyst flow rates in catalytic cracking plants. The radioactivity, extracted from the waste from nuclear piles, is incorporated in catalyst particles. These labeled particles have been used to trace the movement of catalyst in Thermofor catalytic crackers (T.C.C.) and Houdriflow crackers containing both synthetic and natural catalysts.

With minor modifications, the method could be adapted to other processes that utilize moving solids. This radiotracer technique has proved valuable in providing both routine control information and special test data that cannot be obtained readily by other methods.

### Measurement of Catalyst Circulation Rate

The most valuable application of the labeled-catalyst technique has been the measurement of the rate of catalyst circulation through the process vessels of the catalytic cracker. Catalyst circulation rate is one of the critical process variables, and a knowledge of this rate at all times is necessary in order to maintain operation at optimum conditions.

Before the development of the radioactive-bead method of determining catalyst rate, this operating variable was measured by wattmeters or torquemeters in the plants using elevators for catalyst circulation and by correlations of vapor-lift gas rates and pressure drop in the plants using vapor lift for circulating catalyst.

These methods are relatively unreliable and inaccurate, and in the case of the vapor-lift plants, the determination of catalyst rate from vapor-lift conditions is so involved technically and so time consuming that it is useful only during special test periods and has proved of little value for routine control.

The radioactive-tracer method of determining rate of catalyst flow involves the measurement of the time interval required for the passage of a radioactive bead between two points such that the intervening weight of catalyst is accurately defined. The method was tested in the T.C.C. plant of the Richmond refinery, Standard Oil Co. of California, and in the Houdriflow catalytic cracking plant of Salt Lake Refining Co., a subsidiary of Standard of California.

The tracer method was found to be more reliable and more accurate than the earlier methods. These tests established the feasibility of the method for test purposes and connoted its potential value for plant control.

A striking example of the benefits which result from the radioactive-bead method of measuring catalyst circulation rate occurred in the Houdriflow plant of the Salt Lake Refining Co. This plant, which uses a vapor lift for the circulation of catalyst, was operating with only occasional determinations of catalyst circulation rate by the vapor-lift correlation method.

Under these conditions, an emergency developed wherein operating efficiency and capacity declined sharply,

*California Research Corp., Richmond, Calif.

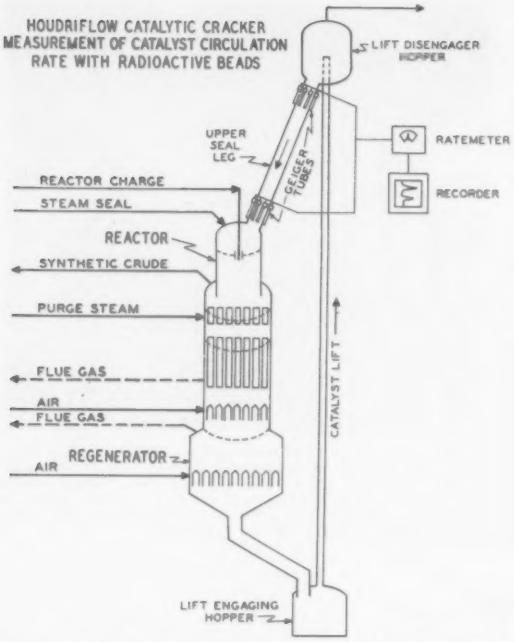


**Fig. 1—Catalyst beads are raised by gas lift to top of plant, flow by gravity through reactor and kiln. As the packed bed descends through upper seal leg, beads labeled with radioactivity register on Geiger counters at top and bottom, indicating rate of circulation.**

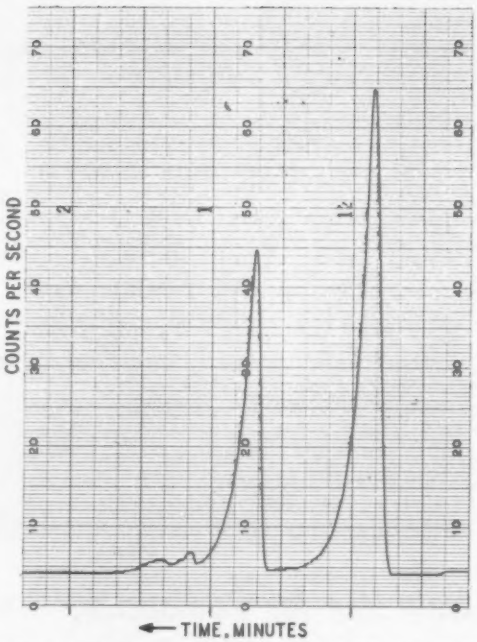


**Fig. 2—A pair of peaks recorded as a radioactive bead passes successively the upper and the lower rings of Geiger counters on the seal leg. The time interval between the peaks indicates the catalyst circulation rate.**

and catalyst loss increased from its normal value to over 10 tons daily. The situation grew so serious that, despite a threatened gasoline shortage, a shutdown was scheduled to permit an internal inspection of vessels and lines in an attempt to correct the difficulty.

A technical service crew from California Research Corp. was called upon to confirm the desirability of shutting down. This crew began test work, including the use of radioactive catalyst beads, 3 days before the scheduled shutdown date. The results of these tests indicated that no mechanical abnormality was causing the difficulty, but that it resulted merely from the circulation of catalyst at too high a rate.

The rate was reduced, and within a short time plant efficiency, capacity, and catalyst makeup rate returned to normal. The shutdown that was averted would have cost an estimated $100,000 and would not have led to the discovery of the source of difficulty. The radioactive-bead method of measuring catalyst circulation rate is presently installed as a routine control instrument in the Salt Lake Houdriflow plant and is considered indispensable. It is also being installed in the vapor lift Houdriflow plants operated by another Standard of California subsidiary, California Oil Co., at Perth Amboy, N. J.

In addition to its application in the determination of catalyst circulation rate which has proved so useful for routine control use, the radioactive-catalyst-bead technique is useful in several other ways. It has been used to calibrate torquemeters and wattmeters which record the rate at which catalyst is circulated by elevators in T.C.C. plants.

Radioactive bead tracers also have been used to study catalyst flow patterns in process vessels and in large catalyst lines; in this application, the use of radioactive beads provided valuable information that could not be obtained by any other known means. In this type of test work, radioactive beads are injected at the desired point by means of a small blowcase, and their movement through the equipment is followed with a portable Geiger counter.

It is anticipated that the tracer bead technique will be used to an increasing extent in test work directed toward the solution of any problems connected with the flow of catalyst.

### Preparation of Radioactive Beads

In making suitable radioactive beads, it is desirable to match as closely as possible the beads customarily used in the plant. The amount of activity required, coupled with the small quantity of a foreign element which can be tolerated in a bead without altering its physical characteristics, makes it necessary to use a radioelement of high specific activity.

A penetrating gamma ray and a half-life comparable to the average lifetime of beads in the plant are other desirable characteristics. Chemically, the radioelement chosen must be stable in both oxidizing and reducing atmospheres at the temperatures of the kiln and reactor.

The radioactive beads are prepared by incorporating a small quantity of the radioisotope with the other catalyst constituents. A typical bead has a radioctivity of about 0.25 milicurie.

### Instruments for Tracing Beads

A typical arrangement of equipment for measuring of catalyst circulation rate is as follows: A ring of Geiger tubes is connected around the top of the standpipe over the reactor which serves as a seal leg against the atmosphere (see Fig. 1). Another ring of tubes is attached to the bottom of the seal leg. All these tubes are connected in parallel into a counting ratemeter, and the output is recorded on a strip chart. This arrangement insures that a radioactive bead cannot follow a path down the seal leg which will not bring

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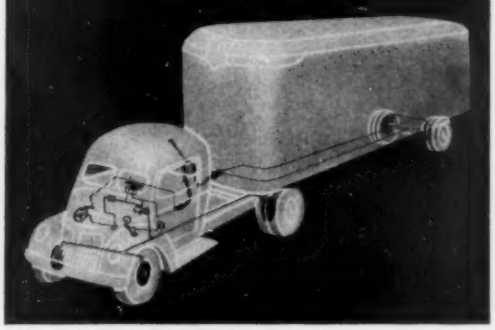

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it within view of at least one of the counters in each ring.

When radioactive beads are put into the circulating system and flow down the seal leg, they produce pairs of peaks like those shown in the chart reproduction (Fig. 2). At fixed plant conditions, the time between pairs of peaks is surprisingly constant, bespeaking uniform flow rates of all beads through the seal leg.

Since this part of the system has accurately known dimensions, it is a simple matter to calculate the weight of catalyst that occupies the space between the two rings of counters. From this weight and the time interval indicated by the radioactive beads, the circulation rate in tons per hour follows directly.

In the instrumentation for routine plant control of circulation rate, the counting rate recorder is in the control room, several hundred feet away from the counters on the seal leg. The time interval between peaks in the counting-rate trace is fed into a computer which plots the circulation rate on a chart calibrated in tons per hour.

Thus, the movement of 10 billion or more ordinary beads in the plant is accurately followed through the use of fewer than a dozen labeled beads. Every time a radioactive bead goes down the seal leg, the circulation rate at that moment is plotted on the chart, giving the operator a check on this important operating variable several times an hour.

### Radiation Safety

As always, when radioactive techniques are adopted, the question of radiation safety has received careful attention. The radioactive beads are prepared in a "hot lab" by skilled radiochemists. They are stored in a lead-lined box at the plant until needed. The maintenance personnel who insert the hot beads in the plant handle them with special tools of suitable length. Their exposure during this work is monitored with radiation dosimeters. The record of such exposure shows that only a small fraction of the accepted tolerance exposure is encountered in this application.

Appropriate steps also are taken to check with a survey meter the catalyst fines and catalyst samples for the presence of a hot bead. No significant radioactivity has been detected. No significant hazard from this standpoint exists because of the short half-life of the radioisotope and its enormous dilution.


### Acknowledgment

Allocation of tracer material by the Isotopes Division of the Atomic Energy Commission made this work possible.

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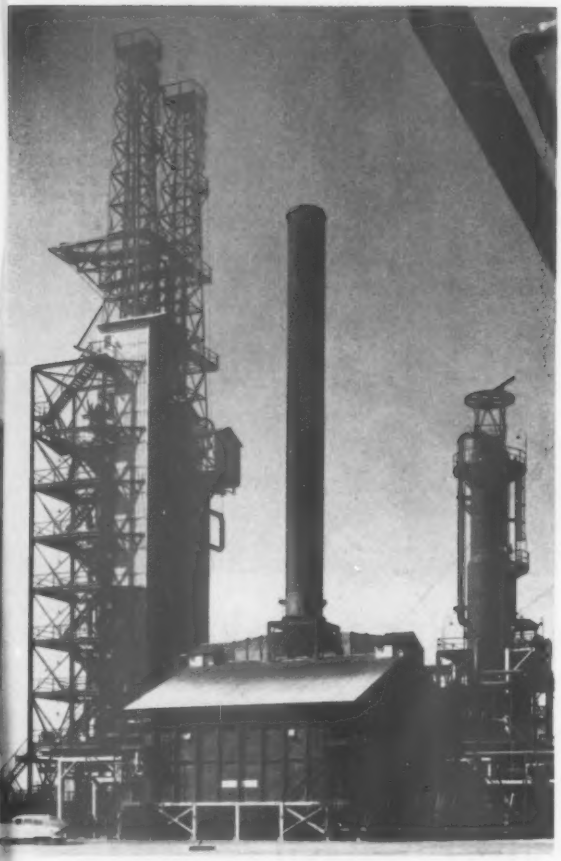

DELAYED COKING is one process used to prepare cat cracker feed. Pictured here is a delayed coking unit at a midwestern refinery.

**TABLE 1—YIELDS PER CENT ON CRUDE**

| | Case I Vacuum Dist. | Case II Delayed Coking | Case III Solvent Decarbonizing |
|---|---|---|---|
| Premium gasoline—93 C.F.R.-R. | 13.2 | 14.0 | 14.0 |
| Regular gasoline—86 C.F.R.-R. | 54.1 | 56.1 | 56.4 |
| Total gasoline | 67.3 | 70.1 | 70.4 |
| Kerosine | 12.0 | 12.0 | 12.0 |
| Furnace oil | 11.4 | 10.7 | 11.9 |
| Fuel oil | 10.1 | 3.0 | 6.8 |
| Gas (fuel oil equivalent) | 8.3 | 11.0 | 8.6 |
| Coke (recoverable) | ... | * 5.4 | ... |

**TABLE 2—PRICE STRUCTURE**

| | Gulf Coast Unit Price | East Coast Unit Price |
|---|---|---|
| Premium gasoline—93 C.F.R.-R, per gal. | $0.1225 | $0.1385 |
| Regular gasoline—86 C.F.R.-R, per gal. | 0.1125 | 0.1285 |
| Kerosine, per gal. | 0.0925 | 0.1075 |
| Furnace oil, per gal. | 0.08625 | 0.0975 |
| Fuel oil, per bbl. | 1.63 | 2.10 |
| Gas (fuel oil equivalent), per bbl. | 0.66 | 2.10 |
| Coke (recoverable), per ton | 10.00 | 10.00 |

**TABLE 3—ECONOMIC COMPARISON—EAST COAST**

| | Case I Vacuum Dist. | Case II Delayed Coking | Case III Solvent Decarbonizing |
|---|---|---|---|
| Incremental credits over Case I, per year | | $1,207,000 | $1,524,000 |
| Incremental investments over Case I (Processing equipment) | | 1,400,000 | 680,000 |

**TABLE 4—ECONOMIC COMPARISON—GULF COAST**

| | Case I Vacuum Dist. | Case II Delayed Coking | Case III Solvent Decarbonizing |
|---|---|---|---|
| Incremental credits over Case I, per year | | $1,153,000 | $1,555,000 |
| Incremental investments over Case I (processing equipment) | | 1,400,000 | 680,000 |

**TABLE 5—BREAKDOWN OF INCREMENTAL INVESTMENT REQUIREMENTS OVER VACUUM DISTILLATION**

| | Case I Vacuum Dist. | Case II Delayed Coking | Case III Solvent Decarbonizing |
|---|---|---|---|
| Delayed coking | ... | $1,300,000 | ... |
| Solvent decarbonizing | ... | ... | $ 350,000 |
| Fluid catalytic cracking | ... | —300,000 | 250,000 |
| Thermal reforming | ... | 400,000 | |
| Catalytic polymerization | ... | ... | 80,000 |
| Total | ... | $1,400,000 | $ 680,000 |

## Economic Evaluation of

# Vacuum Flashing, Delayed Coking, And Solvent Decarbonizing

**by N. R. Adams* and W. J. Price***

FEED-STOCK preparation must be given careful consideration by refiners who are interested in either increasing existing catalytic cracker capacity or erecting new cracking facilities. There are, of course, many methods of preparing the charge stock for catalytic cracking units, but vacuum flashing, delayed coking, and solvent decarbonizing are among the most important commercial processes.

The economic aspects of these three processes have been discussed in a previous paper[1] published in 1946. The comparisons presented here utilize current price structures and equipment costs, thus bringing total investment costs up to date. The value of coke, for instance, has increased considerably in the Gulf Coast area since 1946, and delayed coking now shows an incremental credit rather than deficit with respect to vacuum flashing in this region.

**Education basis . . .** An economic evaluation of these processes can be made in many different ways. In the interest of simplicity, these comparisons are based on the erection of a completely new refinery with a fixed quantity of crude charge. Incremental operating credits attributed to the various feed-preparation processes were derived from an over-all economic balance on the entire processing scheme.

The three hypothetical refineries proposed were designed to charge 40,000 bbl. per calendar day of 38.6° A.P.I. paraffinic crude similar in characteristics to crudes of Mid-Continent origin.

* Process Engineering Department, The M. W. Kellogg Company.

Along with the crude, 4,000 bbl. per calendar day of 26-lb. casing head was processed. Atmospheric topping to 32.5 volume per cent bottoms on crude was followed in all three cases by the preparation of catalytic cracker feed stock from the reduced crude.

Other processes in the over-all refining scheme which were common to all cases were recycle fluid catalytic cracking to a high conversion level, thermal reforming of the virgin heavy naphtha, catalytic polymerization of propylenes and butylenes, and alkylation of butylenes and isobutane.

In Case II the coker gasoline was thermally reformed along with the virgin heavy naphtha. The cat cracker conversion was held constant while the throughput was allowed to vary according to the ability of each feed-preparation process to cut into the reduced crude. The alkylation charge was fixed, while the catalytic polymerization unit was varied in size to accommodate the olefins not utilized by the alkylation unit.

### Results of Comparison

Table 1 presents the product distribution for the three refining schemes, and the yields are shown as volume per cent on crude (40,000 barrels per calendar day). It can be seen that in gasoline production, delayed coking shows 2.8 per cent yield advantage, and solvent decarbonizing a 3.0 per cent increase over the vacuum flashing case.

Two petroleum-refining areas were selected in order to show the effect of price structure on the over-all economic merits of the three feed-stock preparation methods under consideration. In Table 2 the estimated price structures for both the East Coast and Gulf Coast appear.

Using the prices quoted in Table 2, the total credits for the three refining schemes were determined. Direct operating costs on the various processing units within the refineries were then established in order to calculate the over-all net operating credits expected from each of the three cases.

**Operating credits . . .** Knowing the net operating credits for each case, incremental net operating credits with respect to Case I were determined for Cases II and III. Tables 3 and 4 show an economic comparison of the feed preparation units for the East Coast and Gulf Coast refining areas, respectively. Incremental investments covering over-all process equipment are also included in Tables 3 and 4.

Tables 3 and 4 indicate that both delayed coking and solvent decarbonizing are financially more attractive than vacuum distillation for preparing cat cracker feed stock. Although solvent decarbonizing shows an economic ad-

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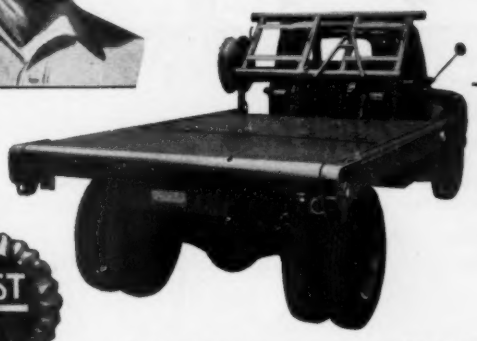

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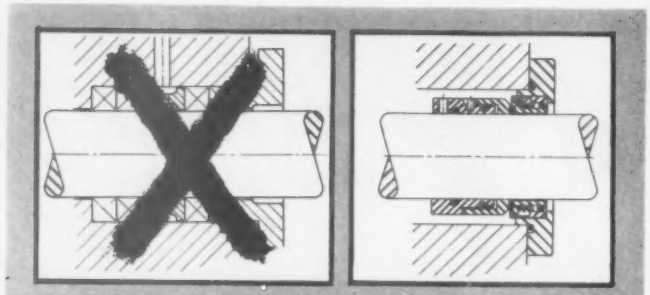

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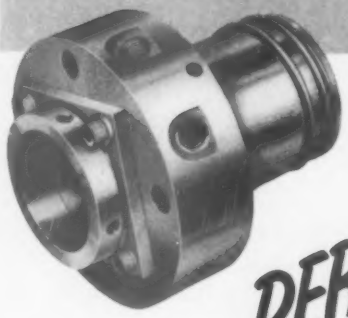

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vantage over delayed coking, the two processes are in a competitive position.

One condition that could slightly affect the relative economic merits of the three cases is the fuel-oil viscosity. The comparison has been made on the assumption that the blended fuel oils could be sold or used in the refinery without adjusting the viscosity. Should it be necessary to produce fuel oi's of constant viscosity, both delayed coking and solvent decarbonizing would improve their position with respect to vacuum flashing. Delayed coking would also move into a more competitive position as compared to solvent decarbonizing.

**Increment investments . . .** Because some of the processing units were allowed to vary in size for the various cases, a breakdown of the incremental investments is tabulated in Table 5. Differences in offsite facilities were not considered since all cases would require approximately the same installations.

The basis used for comparison of vacuum flashing, delayed coking, and solvent decarbonizing is only one of the many conditions which could face a refiner interested in preparing cat cracker charge stock. Often, local conditions or existing refinery equipment which can be made available play an important part in the economic analysis of feed-preparation units.

One other important consideration which must be taken into account is the physical characteristics of the crude oil. Crudes that vary widely in qualities from the paraffinic crude discussed could cause a decided shift in the relative economic position of the preparation processes. For example, high-aspha't-content crudes would necessarily tend to increase the advantage of solvent decarbonizing over vacuum flashing.

Actually the world's largest solvent decarbonizing unit is now under construction handling a charging stock so heavy that it would be uneconomical to process it in vacuum distillation equipment.

**Price structure determines . . .** Though the economic analysis has been presented for the East Coast and Gulf Coast districts only, the local price structure rather than the location of the refinery is the controlling factor. It will be possible, therefore, to apply any set of local prices to the yields and principles developed in this study for the purpose of evaluating the financial attractiveness of vacuum flashing, delayed coking, or solvent decarbonizing.

### References

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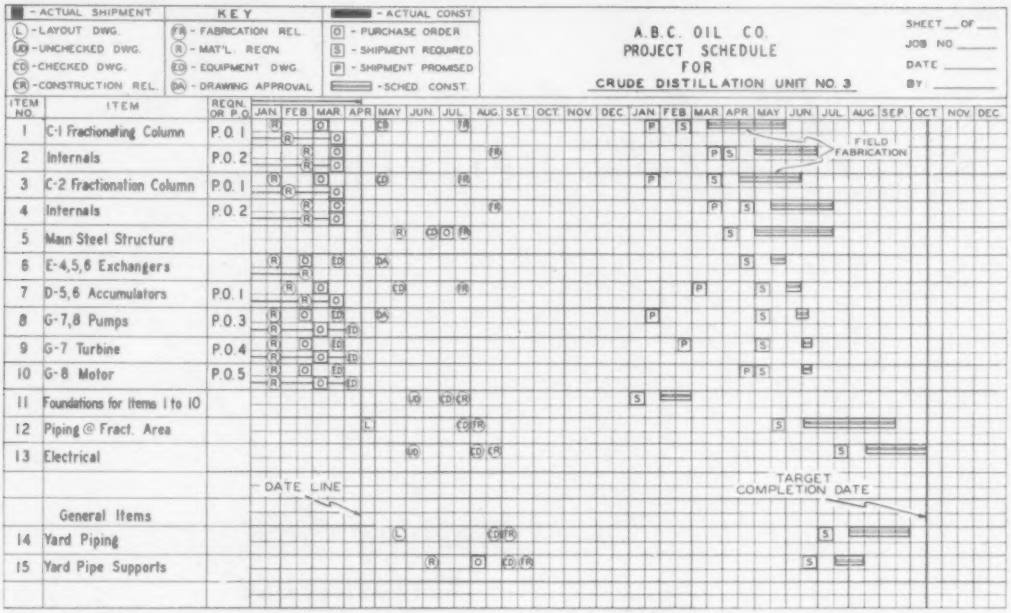
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3 C-2 Fractionation Column P.O. 1
4 Internals P.O. 2
5 Main Steel Structure
6 E-4,5,6 Exchangers
7 D-5,6 Accumulators P.O. 1
8 G-7,8 Pumps P.O. 3
9 G-7 Turbine P.O. 4
10 G-8 Motor P.O. 5
11 Foundations for Items 1 to 10
12 Piping @ Fract. Area
13 Electrical
FIELD FABRICATION
DATE LINE
TARGET COMPLETION DATE
General Items
14 Yard Piping
15 Yard Pipe Supports

**PROJECT SCHEDULE for a refinery construction job. Example shown here is for construction of a crude distillation unit. Fig. 1.**

# . . . How to Prepare the Job Schedule

**by M. Mattozzi***

**WHEN can this job be completed?** This is one of the most insistent questions asked by management during the design, procurement, and erection of process units. The answer can be found only through accurate scheduling. Prediction of the completion date may degenerate to pure "crystal-ball gazing" without proper scheduling.

Very little has been published on the basic principles and data required for good scheduling. Lack of basic information has resulted in various scheduling techniques, few of which have any foundation in fact. It is the purpose of these articles to show how a sound basis may be provided for preparation of such schedules.

**The refiner's position . . .** The quicker a unit is erected, the sooner a return is realized on the investment. In this connection, management, upon approval of a project, sometimes establishes a target date which is not based on a logical design and erection program, but rather on a necessity for producing by that date. Upon analysis these targets are often extremely difficult if not impossible to achieve.

The refiner is in business to market his products. However, if the parties responsible for the erection of a unit are put under pressure to meet an advance completion date, job costs will inevitably rise due to the following:

1. Payment of premium prices to obtain materials quickly.
2. The accompanied increase in expediting costs.
3. Inefficiencies caused by overmanning.
4. Inefficiencies caused by receipt of materials later than anticipated or in illogical construction sequence.

Consequently, poor planning can cause higher costs and yet completion

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Planning and scheduling of refinery process units is an art . . . but sound basic principles and data can be incorporated to make the schedule an effective tool. A series of articles has been prepared for The Oil and Gas Journal. These cover:

1. Schedule data and organization.
2. Engineering and drafting.
3. Erection.
4. Progress reporting.

The author has had extensive experience in this field while employed with a large contractor.

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may not be effected one day sooner than if these additional costs had not been incurred.

**The contractor's position . . .** Scheduling is important to the contractor also. It has been proved that, with sufficient personnel available to man a job effectively, work proceeds more smoothly and economically if properly planned.

Basically, the contractor, to stay in business, must keep these objectives in mind:

1. To earn a profit on the sale of services.

2. To keep a maximum number of clients satisfied.

3. To handle the maximum dollar volume of business with the minimum but most effective staff at a fairly constant level.

Therefore to promote top efficiency and in order to reconcile the viewpoints of management, the engineering and construction department, and contractors generally, a realistic target should be established and all parties concerned work together to that end—completion of the plant on time.

### The Basis for Proper Planning

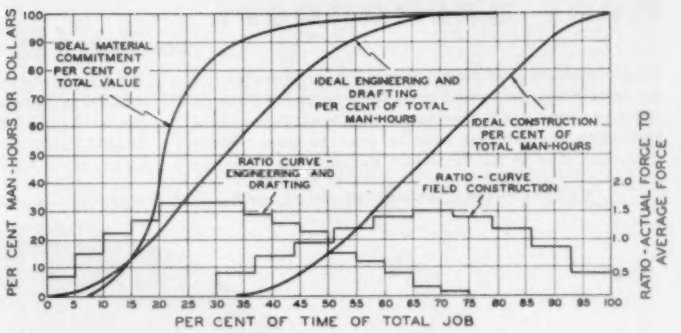
Proper planning should make provision for certain fundamentals:

**1. Engineering and drafting . . .** Work in the engineering department should be scheduled so that a constant flow of activity is maintained without conflicting with other projects at hand.

**2. Requisitioning and procurement . . .** The number of "tight" or emergency purchases should be kept to a bare minimum. Orders for vital materials should be placed without delay. This means early issuance of preliminary requisitions on most major equipment items.

**3. Construction . . .** Assuming that materials arrive in the proper sequence, the flow of work should be so planned that there will be some employment continuity for each craft. For example, if pipe fitters were hired to install underground piping concurrent with foundations and then were to be laid off due to lack of aboveground work, it would be the inclination of the job superintendent or construction engineer to retain men of above-average ability even at a considerable sacrifice in their productivity in order not to lose them.

**Scheduling unit . . .** Schedules can be prepared by the project engineer. However, if several jobs are being designed simultaneously, a scheduling unit should be established in order to avoid conflict between projects and to follow more effectively the progress of each job. Unless scheduling is a function set apart, each engineer may be justified in attempting to schedule his job as if it had top priority. However, such practices would not serve the best interests of management and might result in only one job receiving the major share of attention—not always the right one.


PER CENT MAN-HOURS OR DOLLARS
IDEAL MATERIAL COMMITMENT PER CENT OF TOTAL VALUE
IDEAL ENGINEERING AND DRAFTING PER CENT OF TOTAL MAN-HOURS
IDEAL CONSTRUCTION PER CENT OF TOTAL MAN-HOURS
RATIO CURVE - ENGINEERING AND DRAFTING
RATIO - CURVE FIELD CONSTRUCTION
RATIO - ACTUAL FORCE TO AVERAGE FORCE
PER CENT OF TIME OF TOTAL JOB

**IDEAL CURVE for planning refinery process units. This chart sets the "ideal" pace for engineering and construction performance. Fig. 2.**

### The Schedule

It will be assumed that the problem concerns the scheduling of several jobs being processed at the same time and that the scheduling function will operate as a separate entity.

**Schedule is a tool . . .** The schedule proper must provide for all the elements of information to set up certain objectives. It must also allow for the exercise of some control over the progress of work. **A schedule should be a tool used by everyone contributing effort toward the job and it must be kept up-to-date in order to serve its true purpose.**

**Schedule sheet . . .** This should be flexible enough to indicate by means of appropriate symbols all the vital engineering, drafting, procurement, and construction operations. In addition it should compare the planned schedule with the actual performance for each operation.

The simplest and most effective method of achieving this is to divide each horizontal line on the schedule form into two parts, the upper portion to be used for indicating scheduled operations and the lower half for recording progress as it occurs. The recorder of historical data on the schedule permits a ready analysis of the condition of any item listed thereon, and a complete job history timewise will always be a matter of permanent record.

**Making copies . . .** It is preferable that the schedule be prepared on reproducible vellum. Sufficient copies can then be obtained for distribution and revisions or additions can be incorporated without difficulty. Experience has proved that it is best to have the lines printed on the back of the sheet and the work typed or hand-lettered on the face. This avoids the nuisance caused by smudging of lines when erasures become necessary.

**Time scale . . .** In some organizations a weekly time scale is desirable, in others monthly or semimonthly. The latter usually is flexible enough to serve adequately, since scheduling on a weekly scale, although more precise, loses some of its advantage due to the necessity for large-size sheets.

The preparation of separate schedules for engineering, materials, and construction, are ineffective since the writer has found that due to the difficulty of coordinating three documents, this sort of planning often defeats its own purpose.

It is far more desirable to have one master plan reflecting every major activity and piece of equipment on the contract. In this way, for example, one can quickly recognize the effect of tardy engineering on the purchase of a certain item. With separate schedules, such situations are not readily discernible.

**Symbols . . .** By means of appropriate symbols, all vital operations in all phases should be shown. A simple method is to employ circles to represent specific engineering operations, squares for procurement, and a bar for construction. In addition, the form should provide space for recording drawing numbers, requisition numbers and purchase order numbers. Fig. 1 illustrates

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these points and contains a suggested set of symbols.

However, it is realized that some organizations are not equipped to install a detailed scheduling system. For these a more general method will be discussed later.

### Basic Information

It is assumed that a cost estimate has been prepared. This estimate should contain data that will permit calculation of man-hour figures for both the engineering and construction phases. It is also necessary that the individual preparing the master plan familiarize himself thoroughly with the fundamental design basis. The job specifications prepared prior to mechanical design work provide the best means of obtaining such data.

**Gaging deliveries . . .** While studying the designs specifications, the major equipment items should be noted, along with approximate sizes so that material deliveries can be roughly gaged at the outset. It is good practice to determine which item will probably arrive last at the job site and then reasonably assume that the project will be completed no sooner than the last delivery.

**List of operations . . .** Next it becomes necessary to prepare a list of "control items" and/or operations to be scheduled. To do this comprehensively, there are two additional pieces of essential information required—the process flow sheet and the unit plot plan.

### Using the Plot Plan

With the plot plan as a guide, the project should be divided into several smaller "task areas" and all the equipment, and specific engineering and construction operations within each area listed in a logical sequence. This includes (1) foundations, (2) support structures, (3) columns and internals, (4) drums, (5) heat exchangers (6) pumps and drivers, and (7) piping and electrical work.

**Example . . .** Assume that in one section of the plot plan there are two large fractionating columns with a steel structure between them. The structure in turn supports several heat exchangers and drums and beneath these are located two pumps. These items are listed as per Fig. 1. Other sections of the job should be treated in a similar manner. By conforming to this pattern, the equipment and operations are so related as to permit selectivity in material procurement, expediting, and even in design. Also constant reference to the plot plan to determine location of certain equipment is minimized, pro-


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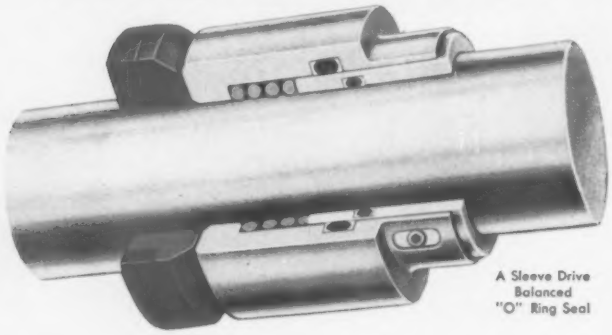

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vided the schedule is kept in agreement.

**Order of erection...** For example, if the columns shown in Fig. 1 were promised for 9 months' delivery, it would be pointless to press for a 3-month delivery of pumps in this area when in all probability they would not be installed until the columns had been erected. On the other hand, the schedule might reflect that certain other pumps were required early in another section and the manufacturer could be advised specifically of the items involved.

**General items...** However, in any project there are various tasks and items of equipment which either can not be related to a specific area or are concerned with the entire plot plan. Such items are yard piping and pipe supports, instrumentation, insulation, etc. These should be listed under a "General" category and are so tabulated in Fig. 1.

### The "Ideal Curve"

A discussion of the "Ideal Curve" is now in order. This chart, Fig. 2, will be immediately recognized by individuals concerned with the planning of refinery process units.

Unfortunately, many schedules have been prepared with misinterpretation of this data as the basis. The chart does have some merit in that it reflects an "ideal" pace for engineering and construction performance. However, the theory that engineering should be concluded when 75 per cent of the total job time has expired is a fallacy, and the start of field construction at the 30 per cent point is rarely practical. This is particularly true under present-day material-delivery conditions, although even under optimum circumstances, the time relationship of engineering to field construction would not be representative.

**Material deliveries...** These usually dictate when construction should be started. A realistic viewpoint in this respect is a major step toward the preparation of an intelligent program. Experience has proved that starting construction too early doesn't necessarily improve the completion date, but rather tends to prolong the erection phase with resultant higher costs. Consequently, a shorter construction period is more desirable, particularly when there is a healthy backlog of material at the job site. The attitude "better to be looking at the material than looking for it" is far more practical.

In the next article of this series the engineering and drafting phase will be discussed.

# The Engineering Contractor

*(Continued from page 284)*

civil, architectural—are represented in the talent pool. There are specialists in pumps, in heat transfer, in fractionation, and in all other fields. This engineering staff has a wide and varied background of experience in all phases of oil, gas, chemical, and other similar industry work. In addition they will have other specialized experience in certain major phases and specific experience in auxiliary phases of process operations, as for example water treating and waste disposal.

The occupational breakdown of salaried personnel employed by 35 engineering construction companies runs like this:

| | |
|---|---|
| Total salaried employes | 8,310 |
| Officials | 320 |
| Project engineers | 264 |
| Key staff engineers (equipment specialists) | 131 |
| Mechanical engineers | 454 |
| Process engineers | 210 |
| Research engineers | 258 |
| Technicians and draftsmen | 4,162 |
| Construction supervision | 1,381 |
| Purchasing and procurement | 339 |
| Office and clerical | 845 |

**The project engineer . . .** The actual number of project engineers varies with the number of projects under way at any particular time of course. Project engineers are vital key men. When not assigned to some specific project they may work on design, improvement, or as assistants on other projects.

For large jobs a manager may be placed in charge. The project manager can then pick one or more project engineers as his assistants. He can also draw from the talent pool of technical specialists as necessary.

The project engineer's experience must be both broad and deep. He must have experience in different branches of the oil, gas, and other industries. He must know processes and units and how they tie in with each other. His knowledge and experience must also be deep in that he must be intimately acquainted with all the details that go to make up a complete job.

He must be familiar with purchasing procedures. He must have a knack for expediting. He must also be a hustler. The project engiener is the man who sets the pace for the job. He works closely with the customer in final selection and acceptance of equipment.

**The project wheel . . .** The project engineer and his immediate assistants are the hub around which the project wheel revolves. The project wheel turns from customer to contractor's engineering. Contractor's engineering staff deals with such items as vessels, pumps, piping, instruments, insulation, and paint. From engineering to purchasing, through bids and procurement, to construction, to initial operation, and finally after startup and inspection back to the customer—that is how the wheel turns. Sales, contracts, process, mechanical, production, and estimating problems by the thousands must be resolved and coordinated between first inception of the project and the time a completed project is turned over to the client.

It has been noted that the technical-manpower pool is backed up by the material resources of the contracting company in the form of modern construction equipment, expensive laboratory, and pilot-plant facilities and in some cases by manufacturing facilities.

**The field force . . .** In addition to many process and mechanical engineers and draftsmen at the home office others are on projects wherever these may be located. The engineering contractor will also have a large field organization which does the field construction work.

One contracting company has nearly 200 field supervisors, including superintendents, assistant superintendents, foremen, and assistant foremen. The company also has field engineering and office personnel who are paid monthly salaries and carried on the payroll throughout the year. The arrangement is such that men not actively engaged in production work are paid a reduced fee as a retainer until such time as their services are again required.

This enables the company to maintain a closely knit organization which may be expanded around a nucleus built up over a period of many years. The company is highly selective in placing field men on the monthly payroll with the idea of building an organization of men who are superior in their various lines.

**Field equipment . . .** This force may, in certain cases, be implemented by a million dollars worth or more of modern construction equipment. As an example of what such equipment might include consider one of the smaller refinery engineering companies which maintains equipment valued at about $200,000. Here is the list:

65 welding machines.
11 large winches.
1 20-ton motor truck crane.
1 stud welding machine.
4 2-ton winch trucks.
5 heavy-duty trucks.
1 tandem pole trailer.
2 sets of 50-ton, 80-ft. gin poles.
2 sets of 75-ton, 110-ft. gin poles.
6 pipe-threading machines.

Other lighter equipment owned includes 5 air vibrators, 6 air tampers, 20 wire rope blocks, 6 transits, 15 portable electric grinders, 8 impact wrenches, 5 radial saws, plus air paving breakers, water pumps, skill saws, etc.

**Purchasing . . .** This is of necessity a highly developed activity in the engineering contractor's organization. In the procurement of equipment, materials, or services quotations are issued only to manufacturers or suppliers who are properly qualified to supply the particular requirements for the individual project.

Upon receipt of all proposals for each individual "Request for Quotation" a bid schedule is made up from which a given supplier can be selected to furnish the equipment.

In addition very close follow-up is maintained of all purchase orders to assure that delivery dates are kept and to expedite delivery where necessary. With experience gained over many years the contractor can procure to the customer's best advantage. The contractor knows sources of supply intimately, together with current price conditions throughout the United States.

### What About the Future?

It may be of interest to look back a little and see what role the engineering contractor has played in the past and then look ahead and see what the future possibilities are.

The contracting company has had a hand in design and engineering of process plants since before World War I. Beginnings may have been modest, but by the time World War II came around the engineering contractor had his hands full with process plant construction projects whose value totaled into the billions.

As the pattern of demand in the refinery industry shifted from kerosine to gasoline, thermal cracking processes were developed. About this time a number of contract engineers came into refinery work, purely as construction companies. A smaller number concentrated on process development without participating in construction work. Others, sooner or later, began to develop a multifunction organization participating in research, development, engineering and construction both in the refinery and other industries.

**Continuous processing . . .** Meanwhile, the petroleum refining industry began to come into its own. Continuous proc-

essing was developed into the closely integrated plant, with flow directly from one unit to the next in the late 1920's and early 1930's. This eliminated intermediate storage and extra piping. It meant a more compact plant. It meant savings in capital investment and also in operating costs. Continuous processing was a great step forward. It also marked a new departure in process design work, requiring more precise and comprehensive engineering data and requiring considerable ingenuity and imagination to predicate optimum flow arrangements and processing conditions.

Combination thermal cracking units which came into the picture in the middle and late 1930's were a good example of the new continuous process ideas of that time. Here was an integrated plant consisting of fractionating tower, thermal cracking furnaces, and gas-recovery units. Flow was continuous throughout many such units built in the late 1930's and they are still in operation now.

**Wartime construction** . . . Participation in construction engineering and development of the newer refinery processing before World War II prepared the engineering contractor for the greater responsibilities and vastly enlarged activities brought on him by the war. All sorts of facilities were under construction at this time—100-octane plants, plants for butadiene from petroleum for synthetic rubber, toluene from petroleum, etc. Under wartime conditions catalytic cracking was brought along much faster than could ever have been contemplated in peacetime.

**Petrochemicals** . . . Another remarkable postwar development has been the construction of petrochemical facilities, mostly centering along the Gulf Coast. Ethylene and propylene have come into demand as starting points for chemicals. After the war it was found that Germany had developed quite a chemistry based on acetylene. Methods for economic production of acetylene from natural gas are presently being developed in the United States. One engineering contracting company is now operating a small commercial plant for acetylene production by the Wulff regenerative furnace method. In connection with this a method has also been developed for the continuous separation of pure acetylene from the reaction gases.

### Future Expansion

The need for additional processing construction can be broken up into three dimensions:

1. Additions of units within a given refinery to meet changing demands.
2. Construction of whole new plants to meet over-all increases in demand.
3. Construction within existing plants to replace obsolete and worn-out equipment.

With current total domestic products demand now at about 8,450,000 bbl. daily (if we add to refinery capacity production of natural-gasoline and cycling plants), a gain of 5 per cent in demand calls for better than 400,000 bbl. daily additional processing capacity. Demand increases in 1950 and 1951 have been about 10 per cent a year but are now beginning to settle back to near-normal 5 per cent. But, this in itself means construction of 400,000 bbl. daily of processing capacity each year.

Again, if average life of processing equipment is set at 20 years (the average probably would be shorter than that), it means that the oil industry has to replace about 5 per cent of its capacity each year or 400,000 bbl. daily.

This normal increase in demand, plus required replacement capacity (including new processing equipment for product improvement without increase in capacity), means that plant construction will continue its upward trend.


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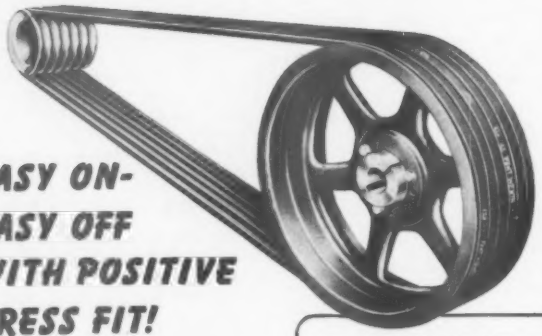

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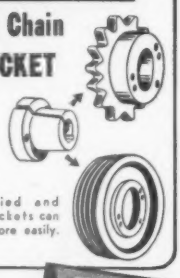

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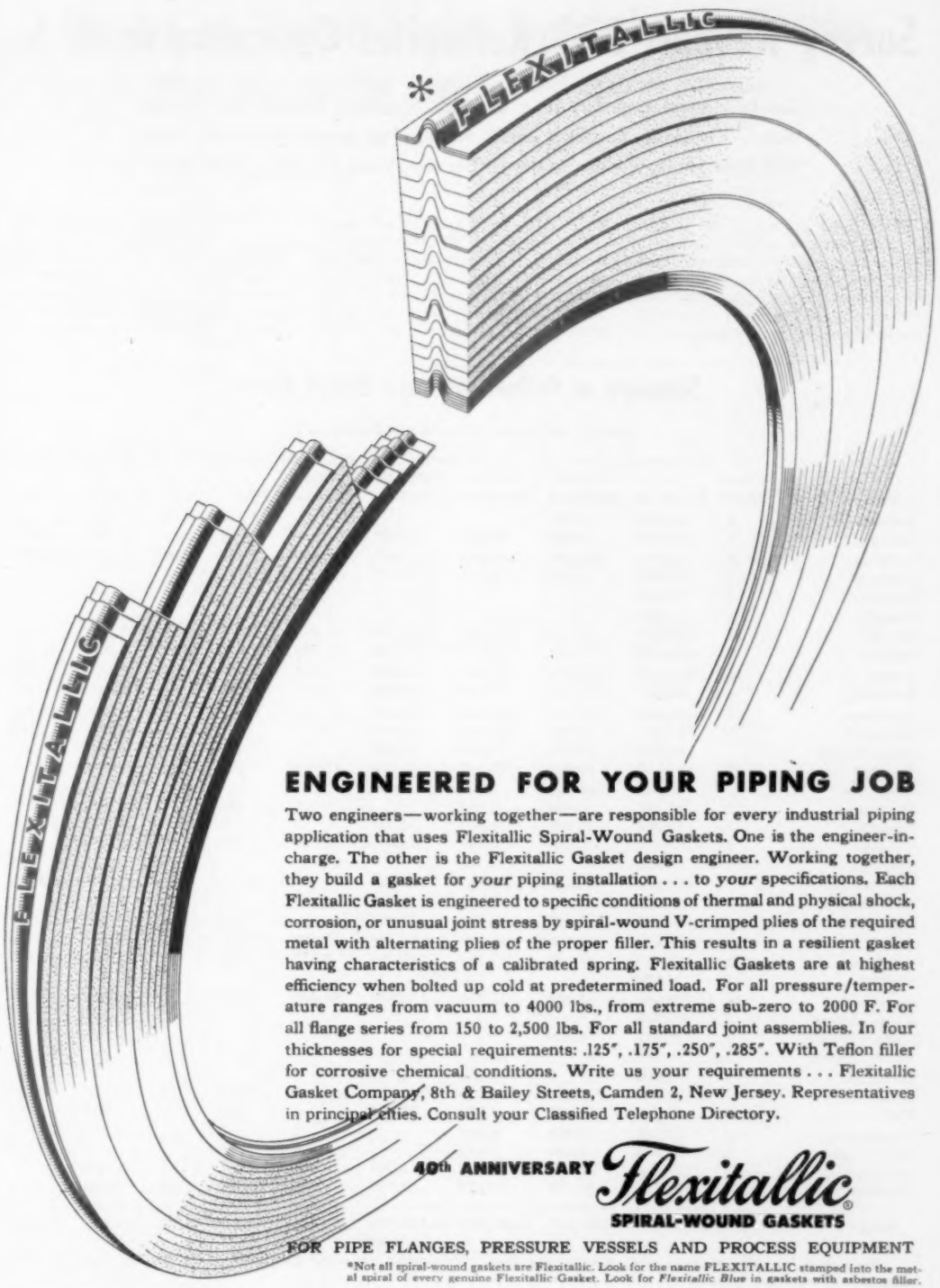


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# Survey Reveals 323 Refineries Operating in U. S.

Crude charge capacity now exceeds 8 million barrels per stream day. Catalytic cracking leads in type of processing, with thermal operations a close second. Survey shows 29 plants shut down.

THIS year's Journal survey of operating refineries in North America is set up on a barrel per stream day basis. With few exceptions all operations are so listed in the accompanying tables. Where a given operation is rated on another basis the exact method of rating is given in a footnote reference.

The number of refineries listed in the recapitulation table below excludes those plants not performing the primary operations in refining of crude oil. The list does not include small operations rated at less than 100 bbl. per day of crude-oil charge, new processes, and plants not scheduled for service in 1953.

Capacity ratings for the various operations reported in the accompanying tables include both idle but operable capacity and additional capacity which is scheduled to go into service this year.

## Summary of Refineries in the United States

THEIR DISTRIBUTION AND CAPACITY

| State— | No. plants | Capacities, bbl. per stream day — Crude oil | Vacuum distillation | Thermal operations | Catalytic cracking | Catalytic reforming | Poly.* | Coke† | Asphalts‡ | Lubes§ |
|---|---|---|---|---|---|---|---|---|---|---|
| Alabama | 3 | 13,000 | 2,000 | | | | | | 9,500 | |
| Arkansas | 6 | 69,700 | 4,400 | 29,800 | 32,500 | | 750 | | 6,000 | 3,550 |
| California | 45 | 1,194,000 | 148,500 | 488,600 | 218,500 | 22,500 | 2,410 | 1,100 | 32,000 | 18,270 |
| Colorado | 7 | 35,206 | 7,500 | 10,600 | 7,983 | | 1,117 | | | |
| Delaware | 1 | 3,500 | | | | | | | 1,500 | |
| Georgia | 1 | 6,000 | | | | | | | | |
| Illinois | 13 | 525,700 | 21,950 | 184,300 | 193,150 | 14,650 | 6,673 | 1,501 | 27,300 | 6,323 |
| Indiana | 9 | 438,600 | 67,100 | 166,600 | 134,200 | 14,000 | 4,610 | 1,210 | 6,925 | 10,180 |
| Kansas | 14 | 265,000 | 62,000 | 98,700 | 140,000 | 2,500 | 6,100 | 310 | 12,800 | 3,500 |
| Kentucky | 6 | 86,300 | 34,500 | 26,000 | 30,000 | | 2,350 | | 12,000 | 600 |
| Louisiana | 15 | 661,528 | 100,000 | 130,611 | 281,728 | 23,000 | 6,542 | | 12,500 | 16,250 |
| Maryland | 3 | 77,500 | 14,000 | 16,500 | 32,000 | | | | 19,500 | 250 |
| Massachusetts | 1 | 50,000 | 13,100 | 15,150 | 24,000 | | 1,200 | | 7,000 | |
| Michigan | 16 | 153,900 | 16,000 | 28,100 | 32,000 | 17,900 | 670 | 145 | 5,800 | |
| Minnesota | 2 | 40,000 | 10,000 | | 5,000 | | | | 7,000 | |
| Mississippi | 2 | 11,000 | 1,000 | 2,000 | | | 200 | | 3,000 | |
| Missouri | 1 | 73,000 | 7,200 | 48,300 | 32,000 | | 1,800 | 505 | 4,000 | |
| Montana | 8 | 61,989 | 5,280 | 14,550 | 21,667 | | 1,712 | | 6,650 | |
| Nebraska | 3 | 3,600 | | 850 | | | | | | |
| New Jersey | 7 | 485,500 | 70,300 | 100,955 | 205,889 | | 10,389 | | 15,700 | 15,400 |
| New Mexico | 8 | 23,611 | | 7,311 | 6,000 | 2,150 | 412 | | 1,500 | |
| New York | 6 | 110,000 | 13,000 | 18,300 | 40,000 | | 825 | | 4,000 | 4,700 |
| Ohio | 11 | 346,650 | 43,900 | 140,800 | 138,100 | 20,000 | 9,695 | 655 | 7,000 | 3,700 |
| Oklahoma | 21 | 358,733 | 66,189 | 113,994 | 113,367 | 8,833 | 6,890 | 470 | 12,300 | 10,922 |
| Oregon | 1 | 6,500 | | | | | | | 6,250 | |
| Pennsylvania | 16 | 550,950 | 62,100 | 132,750 | 220,500 | 54,000 | 10,830 | | 5,200 | 31,650 |
| Rhode Island | 3 | 13,500 | | | | | | | 3,400 | |
| South Carolina | 1 | 8,000 | 6,400 | | | | | | 4,500 | |
| South Dakota | 1 | 200 | | | | | | | | |
| Tennessee | 2 | 7,000 | | 1,200 | 2,700 | | | | | |
| Texas | 63 | 2,200,178 | 212,855 | 743,089 | 781,670 | 112,600 | 24,863 | 390 | 20,750 | 58,000 |
| Utah | 5 | 69,500 | 12,000 | 7,700 | 37,000 | | 250 | | 800 | 120 |
| Washington | 3 | 12,500 | 2,400 | 3,600 | | | 40 | | 3,100 | |
| West Virginia | 3 | 12,500 | 1,500 | 7,150 | | 1,500 | 210 | | | 2,550 |
| Wisconsin | 2 | 11,000 | 2,000 | 1,000 | 1,000 | 2,000 | | | 1,200 | |
| Wyoming | 14 | 108,438 | 20,500 | 25,525 | 39,750 | 1,000 | 1,900 | 218 | 8,640 | 650 |
| Total | 323 | 8,094,283 | 1,027,674 | 2,564,035 | 2,770,704 | 296,633 | 102,438 | 6,504 | 267,815 | 186,615 |

*Production capacity, thermal and catalytic processes. †Production capacity, tons daily. ‡Production capacity, total asphalts. §Production capacity.

# Report on United States Operating Refineries

## *Where they are, their capacities, and types of processes*

**EXPLANATION OF ABBREVIATIONS USED IN TABLES**

**Refinery type:**
S—Crude-oil distillation
A—Asphalt
L—Lubricating oils
C—Cracking, reforming, etc.
W—Wax
Comp.—Complete refinery, includes S-C-L plus A and/or W

**Type of thermal operations:**
C—Cracking
Ck—Coking
V—Vis breaking

R—Reforming

**Type of catalytic cracking:**
Cy—Cycloversion
F—Fluid
Ho—Houdriflow
Hy—Houdry
S—Suspensoid
T—Thermofor

**Type of catalytic reforming:**
At—Atlantic
Cy—Cycloversion
H—Houdriforming
Hf—Hydroforming
Pf—Platforming
T—Thermofor

**Type of polymerization:**
C—Catalytic
T—Thermal

**Asphalt production:**
S—Straightrun
O—Oxidized
M—Other

### ALABAMA

| Company, plant location and type— | Capacity ratings: Charging, bbl. per stream day: Crude oil | Vacuum dist. | Thermal operations | Cat. cr. | Cat. ref. | Production: Poly. | Coke, tons per day | Asphalt | Lubes |
|---|---|---|---|---|---|---|---|---|---|
| Am. Bit. & Asphalt Co.: | | | | | | | | | |
| Mobile (S-A) | [1]6,000 | | | | | | | S 4,800 | |
| | | | | | | | | O 900 | |
| | | | | | | | | M 2,300 | |
| Hunt Oil Co.: | | | | | | | | | |
| Tuscaloosa (S-A) | [2]4,500 | | | | | | | ([3]) | |
| Vulcan Asphalt Ref. Co.: | | | | | | | | | |
| Cordova (S-A) | 2,500 | 2,000 | | | | | | S 1,500 | |
| Total | 13,000 | 2,000 | | | | | | 9,500 | |

(1) Vacuum operation for primary distillation of crude oil. (2) Estimated. (3) Not reported.

### ARKANSAS

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Berry Asphalt Co.: | | | | | | | | | |
| Stephens (S-A) | 1,800 | 1,800 | | | | | | S 700 | |
| Waterloo (S-L-A) | [1]1,400 | 1,400 | | | | | | S 650 | 500 |
| | | | | | | | | O 500 | |
| Henry H. Cross Co.: | | | | | | | | | |
| Smackover (S-L-A) | [2]6,000 | 1,200 | | | | | | S 700 | 700 |
| Lion Oil Co.: | | | | | | | | | |
| El Dorado (Comp.) | [4]23,500 | | | F [5]10,000 | | C 400 | | S [6]3,000 | 1,000 |
| | | | | T 6,000 | | | | O [6]450 | |
| Macmillan Pet. Corp.: | | | | | | | | | |
| El Dorado (S-L-A) | 4,000 | | | | | | | ([7]) | [8]1,350 |
| Pan American Southern Corp.: | | | | | | | | | |
| El Dorado (S-C) | 33,000 | | C 13,500 | F 16,500 | | | | | |
| | | | R 7,000 | | | C 350 | | | |
| | | | Ck 9,300 | | | | ([7]) | | |
| Total | 69,700 | 4,400 | 29,800 | 32,500 | | 750 | | 6,000 | 3,550 |

(1) Includes 400 bbl. per day of idle capacity. (2) Refinery currently operating at 50 per cent of capacity. Vacuum operation charging crude oil. (3) Vacuum operation included in primary distillation of crude oil. (4) Includes 1,500 bbl. per day to be added during 1953. (5) To go into service in 1953. (6) Estimated. (7) Not reported.

### CALIFORNIA

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Bankline Oil Co.: | | | | | | | | | |
| Bakersfield (S-C) | 7,000 | | C 3,000 | | | | | | |
| Calstate Ref. Co.: | | | | | | | | | |
| Long Beach (C) | ([1]) | | C [2]2,500 | | | | | | |
| Caminol Co.: | | | | | | | | | |
| Hanford (S-C) | 5,000 | 2,000 | C 1,000 | | | | | | |
| | | | V 1,000 | | | | | | |
| | | | R 500 | | | | | | |
| Century Oil Co.: | | | | | | | | | |
| Long Beach (S) | 5,000 | | | | | | | | |
| Douglas Oil Co. of Calif.: | | | | | | | | | |
| Bakersfield (S-C-A) | 8,400 | | C 4,500 | | | | | | |
| Paramount (S-A) | [3]5,000 | 4,000 | | | | | | S 2,500 | |
| | | | | | | | | O 2,000 | |
| Edgington Oil Refs., Inc.: | | | | | | | | | |
| Long Beach (S-L-A) | [4]6,500 | | | | | | | S 3,500 | 600 |
| | | | | | | | | O 2,000 | |
| Edgington Oil Refinery: | | | | | | | | | |
| Oxnard (S-A) | 2,500 | | | | | | | S 1,750 | |
| Envoy Pet. Co.: | | | | | | | | | |
| Long Beach (S) | [5]5,000 | | | | | | | | |

CALIFORNIA (Continued)

| Company, plant location and type | Capacity ratings: Charging, bbl. per stream day — Crude oil | Vacuum dist. | Thermal operations | Cat. cr. | Cat. ref. | Production: Poly. | Coke, tons per day | Asphalt | Lubes |
|---|---|---|---|---|---|---|---|---|---|
| Eureka Ref. Corp.: | | | | | | | | | |
| Long Beach (S) | 5,000 | | | | | | | | |
| Five C Ref. Co.: | | | | | | | | | |
| Santa Maria (S-A) | [6]3,500 | 3,500 | | | | | | S 2,450 | |
| General Pet. Corp.: | | | | | | | | | |
| Torrance (S-C) | [7]125,000 | 38,000 | V 28,000<br>Ck 26,000 | T 52,000 | | C 500 | 1,100 | | |
| Vernon (S-A) | [8]4,000 | | | | | | | S 2,000 | |
| Golden Bear Oil Co.: | | | | | | | | | |
| Oildale (S-L-A) | [9]3,000 | | | | | | | S 1,200 | 800 |
| Hancock Oil Co.: | | | | | | | | | |
| Long Beach (S-C) | 12,500 | | V 10,000 | | | | | | |
| McCallen Ref. Co., Ltd.: | | | | | | | | | |
| Huntington Beach (S-A) | 5,000 | | | | | | | S 500 | |
| Macmillan Pet. Corp.: | | | | | | | | | |
| Long Beach (S-A) | 7,600 | | | | | | | [10] | |
| Mohawk Pet. Corp.: | | | | | | | | | |
| Bakersfield (S-C) | 11,000 | | C 3,800 | | | C 60 | | | |
| Newhall Ref. Co.: | | | | | | | | | |
| Newhall (S) | 3,000 | | | | | | | | |
| Oxnard Oil & Ref. Co.: | | | | | | | | | |
| Oxnard (S) | [11]2,500 | | | | | | | | |
| Pabco Products Co., Inc.: | | | | | | | | | |
| Emeryville (S-A) | [11]2,500 | | | | | | | O [12]12,000 | |
| Palomar Oil & Ref. Corp.: | | | | | | | | | |
| Bakersfield (S) | 1,300 | | | | | | | | |
| Richfield Oil Corp.: | | | | | | | | | |
| Watson (S-C-A) | [12]120,000 | | C 50,000 | T 25,000 | | C 350 | | [13]3,000 | |
| Rothchild Oil Co.: | | | | | | | | | |
| Santa Fe Springs (S-C) | [14]14,500 | | C [11]1,500 | | | | | | |
| Seaside Oil Co.: | | | | | | | | | |
| Ventura (S-A) | 4,500 | | | | | | | S 300 | |
| Shell Oil Co.: | | | | | | | | | |
| Martinez (S-C-L-A) | 55,000 | | C 30,000 | | | | | S 4,200 | 3,100 |
| Wilmington (S-C) | 64,000 | | C 36,000 | F 25,000 | | | | | |
| Socal Oil & Ref. Co.: | | | | | | | | | |
| Huntington Beach (S-C) | 2,500 | | C 1,600 | | | | | | |
| Standard Oil Co. of Calif.: | | | | | | | | | |
| El Segundo (S-C-A | [15]127,000 | | [16]69,000 | | Pf 10,000 | | | [17]1,000 | |
| Richmond (Comp.) | 138,000 | 50,000 | [15]56,000 | T 20,000 | [17]12,500 | | | [17]2,000 | 9,000 |
| Bakersfield (S-C-A) | 18,000 | | C 8,000 | | | | | [18]200 | |
| Sunland Ref. Corp.: | | | | | | | | | |
| Bakersfield (S-C) | [19]6,000 | | C 1,200 | | | T 300 | | | |
| Sunray Oil Corp.: | | | | | | | | | |
| Santa Maria (S-C-A) | [11]7,500 | | C [11]3,000 | | | | | [10] | |
| Sunset Oil Co.: | | | | | | | | | |
| Torrance (S-C) | [20]9,000 | | C [21]2,500 | | | T [21]400 | | | |
| Superior Asphalt Co.: | | | | | | | | | |
| Oxnard (S-A) | 1,800 | | | | | | | S 1,400 | |
| The Texas Co.: | | | | | | | | | |
| Wilmington (S-C) | 60,000 | | C 10,000 | F 20,000 | | | | | |
| Tide Water Assoc. Oil Co.: | | | | | | | | | |
| Avon (Comp.) | [22]88,000 | [23]36,000 | [16]37,200 | F 28,000 | | | | | 1,670 |
| Watson (S-C) | [24]15,000 | | V 9,000 | | | | | | |
| Triangle Oil & Ref. Co.: | | | | | | | | | |
| Venice (S) | [11]2,500 | | | | | | | | |
| Union Oil Co. of Calif.: | | | | | | | | | |
| Maltha (S-C-A) | [25]8,100 | | | | | | | [10] | |
| Rodeo (Comp.) | [26]82,800 | | Ck [27]20,000<br>C [27]24,000 | | | C [26]200 | [10] | [10] | 3,100 |
| Wilmington (S-C) | [29]110,000 | | C [30]33,000 | T [30]16,000<br>F [30]27,000 | | | | | |
| Western Asphalt & Ref. Co.: | | | | | | | | | |
| Santa Maria (S) | 1,500 | | | | | | | | |
| Wilshire Oil Co., Inc.: | | | | | | | | | |
| Norwalk (S-C) | 24,000 | 15,000 | C 15,000 | F 5,500 | | C 600 | | | |
| Total | 1,190,000 | 148,500 | 487,300 | 218,500 | 22,500 | 2,410 | 1,100 | 32,000 | 18,270 |

(1) Cracking operations only. Processes stock obtained from Century Oil Co. (2) Includes 500 bbl. per day to be added in 1953. (3) Includes 1,000 bbl. per day of idle capacity. (4) Includes 2,000 bbl. per day of idle capacity. (5) Capacity when operating on light crude oil. (6) Includes 1,250 bbl. per day of idle capacity. (7) Includes 33,700 bbl. per day of idle capacity. (8) Includes 2,890 bbl. per day of idle capacity. (9) Vacuum operation charging crude oil. (10) Not reported. (11) Estimated. (12) Includes 7,000 bbl. per day of crude oil charged to vacuum units and T.C.C. plant. (13) Total asphalt production. (14) Capacity on two plants, estimated. (15) Includes 10,000 bbl. per day of idle capacity. (16) Total for thermal operations. (17) Total asphalt production, estimated. (18) Total catalytic reforming. (19) Net capacity and exclusive of idle facilities. (20) Includes 4,500 bbl. per day of idle capacity. (21) To be added in 1953. (22) Includes 13,000 bbl. per day of idle capacity. (23) Excludes 18,000 bbl. per day operating on crude oil. (24) Includes 3,000 bbl. per day idle capacity. (25) Barrels per calendar day basis and includes 2,300 bbl. daily to road oil and asphalt units. (26) Barrels per day basis and includes crude oil to coking thermal cracking units plus 4,800 bbl. daily to lube and asphalt operations. (27) Operating on crude oil. (28) Not operating. (29) Barrels per calendar day basis and includes 61,000 bbl. per day to combination units and 11,000 bbl. per day of idle topping capacity. (30) Barrels per calendar day.

## THEY'RE LOOKING DOWN YOUR PIPELINE...

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**H. K. PORTER COMPANY, INC.**
126 ALDENE RD., ROSELLE, NEW JERSEY

## COLORADO

| Company, plant location and type | Capacity ratings: Charging, bbl. per stream day: Crude oil | Vacuum dist. | Thermal operations | Cat. cr. | Cat. ref. | Production: Poly. | Coke, tons per day | Asphalt | Lubes |
|---|---|---|---|---|---|---|---|---|---|
| Bay Pet. Corp., The: | | | | | | | | | |
| Denver (S-C) | [1]12,000 | [5]5,000 | C 1,900 | F [2]3,500 | ..... | T 200 | ..... | ..... | ..... |
| | ..... | ..... | V [2]3,000 | ..... | ..... | C [2]500 | ..... | ..... | ..... |
| Continental Oil Co.: | | | | | | | | | |
| Denver (S-C) | 9,556 | ..... | C 2,000 | T 3,333 | ..... | C 417 | ..... | ..... | ..... |
| Empire Pet. Co.: | | | | | | | | | |
| Denver (S) | [3]5,000 | 2,500 | ..... | ..... | ..... | ..... | ..... | ..... | ..... |
| Oriental Ref. Co.: | | | | | | | | | |
| Alamosa | 1,000 | ..... | C [4]900 | ..... | ..... | ..... | ..... | ..... | ..... |
| Denver | 4,000 | ..... | C [4]2,000 | ..... | ..... | ..... | ..... | ..... | ..... |
| Skelly Oil Co.: | | | | | | | | | |
| Denver (S-C) | 1,650 | ..... | C 800 | ..... | ..... | ..... | ..... | ..... | ..... |
| Wesco Ref. Co.: | | | | | | | | | |
| Rangely (S-C) | 2,000 | ..... | ..... | F [5]1,150 | ..... | ..... | ..... | ..... | ..... |
| Total | 35,206 | 7,500 | 10,600 | 7,983 | ..... | 1,117 | ..... | ..... | ..... |

(1) Includes 5,500 bbl. per day to be added in 1953. (2) Under construction and scheduled for service in 1953. (3) Includes 3,000 bbl. per day to be added in 1953. (4) Estimated. (5) To be added in 1953.

## DELAWARE

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| The Texas Co.: | | | | | | | | | |
| Claymont (S-A) | 3,500 | ..... | ..... | ..... | ..... | ..... | ..... | S [1]1,500 | ..... |

(1) Estimated.

## GEORGIA

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Mexican Pet. Corp., Ga.: | | | | | | | | | |
| Savannah (S) | 6,000 | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... |

## ILLINOIS

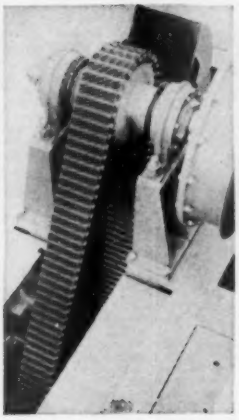
| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Advance Ref. Co., Inc.: | | | | | | | | | |
| Centralia (S-C) | 2,500 | ..... | ..... | [1]650 | ..... | ..... | ..... | ..... | ..... |
| Calumet Ref. Co.: | | | | | | | | | |
| Burnham (S-L) | 1,200 | 750 | ..... | ..... | ..... | ..... | ..... | ..... | 750 |
| Henry H. Cross Co.: | | | | | | | | | |
| Colmar (S) | [2]1,000 | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... |
| Globe Oil & Ref. Co.: | | | | | | | | | |
| Lemont (S-C) | [3]37,000 | ..... | C [3]15,000 | F [3]6,000 | ..... | C [3]900 | ..... | ..... | ..... |
| | ..... | ..... | R [3]6,500 | ..... | ..... | ..... | ..... | ..... | ..... |
| Ohio Oil Co., The: | | | | | | | | | |
| Robinson (Comp.) | 40,000 | ..... | C 9,000 | F [5]18,000 | H [4]8,000 | C [5]1,600 | 200 | S 5,000 | [4]200 |
| | ..... | ..... | Ck [6]6,000 | ..... | ..... | ..... | ..... | O 5,000 | ..... |
| Pana Ref. Co.: | | | | | | | | | |
| Pana (S-C) | [7]6,000 | ..... | C 2,200 | ..... | Pf [4]650 | C 100 | ..... | ..... | ..... |
| Petco Corp.: | | | | | | | | | |
| Blue Island (S-C) | [3]20,000 | ..... | C [3]5,000 | Ho [3]7,500 | ..... | ..... | ..... | ..... | ..... |
| | ..... | ..... | R [3]1,500 | ..... | ..... | ..... | ..... | ..... | ..... |
| | ..... | ..... | V [3]1,000 | ..... | ..... | ..... | ..... | ..... | ..... |
| Shell Oil Co.: | | | | | | | | | |
| Wood River (Comp.) | [8]185,000 | ..... | C 15,500 | F [9]55,000 | ..... | C 850 | 685 | S 3,500 | 3,100 |
| | ..... | ..... | R 20,000 | ..... | ..... | ..... | ..... | ..... | ..... |
| | ..... | ..... | Ck 11,000 | ..... | ..... | ..... | ..... | ..... | ..... |
| Sinclair Ref. Co.: | | | | | | | | | |
| Hartford (S-C-A) | 28,000 | 15,000 | C 6,000 | F 11,000 | Cy 6,000 | C 600 | ..... | S 1,500 | ..... |
| | ..... | ..... | ..... | ..... | ..... | ..... | ..... | O 500 | ..... |
| Socony-Vacuum Oil Co., Inc.: | | | | | | | | | |
| E. St. Louis (S-C) | 40,000 | ..... | [12]13,200 | T [10]24,000 | ..... | (11) | 240 | ..... | ..... |
| | ..... | ..... | Ck 9,000 | ..... | ..... | ..... | ..... | ..... | ..... |
| Standard Oil Co. (Ind.): | | | | | | | | | |
| Wood River | 50,000 | 6,200 | C 10,200 | F 16,000 | ..... | C 123 | 126 | S 2,500 | 1,073 |
| | ..... | ..... | V 3,400 | ..... | ..... | ..... | ..... | O 2,500 | ..... |
| | ..... | ..... | R 7,060 | ..... | ..... | ..... | ..... | M 1,800 | ..... |
| | ..... | ..... | Ck 3,740 | ..... | ..... | ..... | ..... | ..... | ..... |
| The Texas Co.: | | | | | | | | | |
| Lawrenceville (Comp.) | 50,000 | ..... | C 14,000 | F 30,000 | ..... | C 2,000 | ..... | [13]2,000 | 1,200 |
| Lockport (S-C-A) | 65,000 | ..... | C 13,000 | F 25,000 | ..... | C 500 | 250 | [13]3,000 | ..... |
| | ..... | ..... | Ck 12,000 | ..... | ..... | ..... | ..... | ..... | ..... |
| Total | 525,700 | 21,950 | 184,300 | 193,150 | 14,650 | 6,673 | 1,501 | 27,300 | 6,323 |

(1) Type not reported. (2) Currently operating at reduced capacity. (3) Estimated. (4) New capacity. (5) Includes 3,500 bbl. per day to be added in 1953. (6) Includes 300 bbl. per day to be added in 1953. (7) Includes 1,500 bbl. per day to be added in 1953. (8) Includes 50,000 bbl. per day of capacity to be added in 1953. (9) Includes 5,000 bbl. per day to be added in 1953. (10) Includes 15,000 bbl. per day of additional capacity for 1953. (11) Not reported. (12) Total thermal operations. (13) Total asphalts.

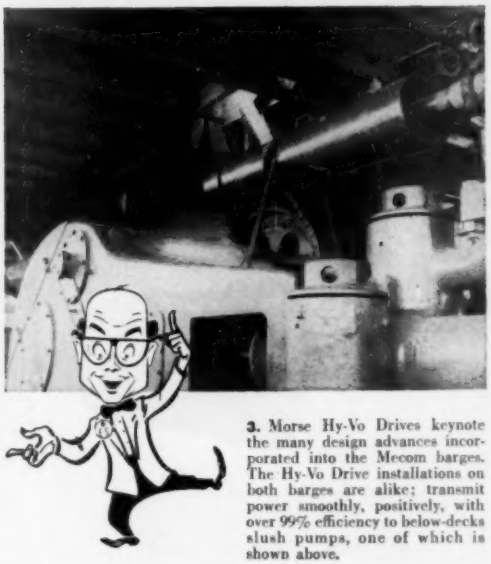
## INDIANA

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Cities Service Oil Co. (Del.): | | | | | | | | | |
| E. Chicago (S-C) | 40,000 | ..... | R 2,700 | F 16,000 | ..... | ..... | 280 | ..... | ..... |
| | ..... | ..... | Ck 8,900 | ..... | ..... | ..... | ..... | ..... | ..... |

1. A 2"-pitch x 8"-wide Morse Hy-Vo Drive transmits power at 4350 fpm. velocity from two 520 hp. GM Diesel Quads, in above-deck drawworks to below-deck power slush pump.

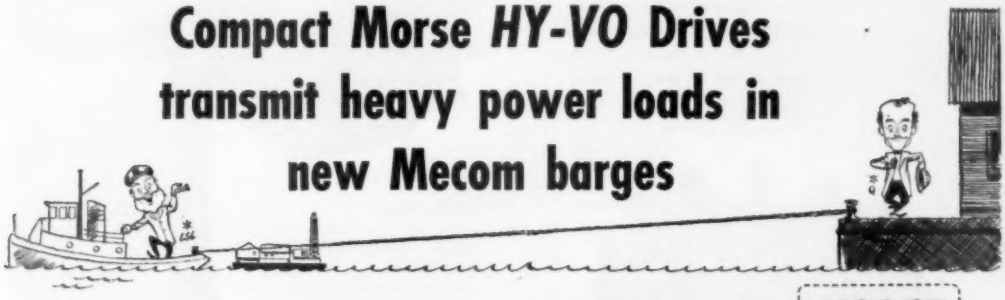


2. Above-deck view of Hy-Vo Drive pictured at left. Note trimness of unit. Another Morse Hy-Vo Drive, 2"-pitch x 6"-wide, not pictured, transmits power from compounded Diesels to a second below-deck slush pump.



3. Morse Hy-Vo Drives keynote the many design advances incorporated into the Mecom barges. The Hy-Vo Drive installations on both barges are alike; transmit power smoothly, positively, with over 99% efficiency to below-decks slush pumps, one of which is shown above.

# Compact Morse *HY-VO* Drives transmit heavy power loads in new Mecom barges



John W. Mecom Company, Houston, Texas, has incorporated many important design, engineering, and performance advances in its two new drilling barges.

One of the most significant advances is the use of revolutionary, performance-proved Morse Hy-Vo Drives.

### Cash savings

Morse Hy-Vo Drives, because of their unique design characteristics, overcome many of the limitations of other methods of transmitting power. They make possible the use of smaller, higher-speed, less costly engines and motors. For instance, a Morse Hy-Vo Drive can transmit up to 5000 hp., can operate at speeds of 3600 rpm., can run at linear velocities of 6500 fpm. Hy-Vo reduces operating costs by as much as 50%, gives up to one-third longer service life. Runs far more coolly, with far less noise, too.

Hy-Vo, in many instances, does away with expensive, bulky outboard bearings; permits savings in space and weight never before possible. It provides smooth-flowing, positive power transmission throughout its extra-long, trouble-free service life.

Think over your tough, high-speed, heavy-duty power transmission applications with Morse Hy-Vo in mind. Then let us give you specific information. Or, send coupon for general information.

*Engineering Service, Long Service Life, Quality—which you get in unusual degree when you buy Morse Power Transmission Products.

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119 Federal Street

M = PT; Morse *means* Power Transmission

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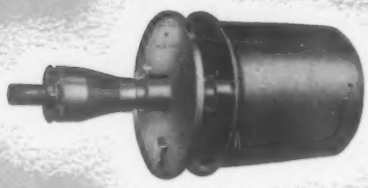

## SERIES HBM —

**SHORT FLAME GAS BURNER**

Inexpensive to buy—easy to install. All in one piece—just brick into furnace wall.
Can be used with high or low pressure gas.
Slugs of water, oil or gasoline blow through them or run down over them without doing damage.
Available for vertical or horizontal firing.
Burns with a short flame, without the use of small ports. refinery gases, natural gas, oil vapors or a mixture of gases.

## SERIES CBM —

**COMBINATION GAS & OIL BURNER**

Full rating may be taken with completely satisfactory fires with either fuel.
Both fuels may be fired in combination if necessary.
A new file and register design permits operation at low excess air.
Any gaseous fuel at pressure in excess of 5 lbs. may be burned.
Any commercial grade of fuel oil may be burned when properly prepared.

## SERIES VBM —

**GAS & COMBINATION GAS & OIL BURNER**

They permit the release of more heat units per cubic foot of furnace volume.
They are the first really satisfactory combination gas and oil burners for vertical firing.
They permit perfectly even distribution of heat in the furnace.
Any gaseous fuel at pressures in excess of five pounds may be burned perfectly satisfactory.
Any commercial fuel oil may be burned when properly prepared.
Extreme simplicity of design and ease of control prevent operational difficulty.
High sulphur content gases may be burned without port stoppage.
They give maximum duty with a minimum of furnace draft.

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# JOHN ZINK COMPANY

4401 South Peoria — Tulsa, Oklahoma

## INDIANA (Continued)

| Company, plant location and type— | Charging, bbl. per stream day: Crude oil | Vacuum dist. | Thermal operations | Capacity ratings: Cat. cr. | Cat. ref. | Production: Poly. | Coke, tons per day | Asphalt | Lubes |
|---|---|---|---|---|---|---|---|---|---|
| Indiana Farm Bureau Coop. Assn., Inc.: | | | | | | | | | |
| Mount Vernon (S-C) | 9,600 | 3,600 | C 3,200 | F 3,600 | ..... | T 260 | ..... | ..... | ..... |
| | ..... | ..... | ..... | ..... | ..... | C 540 | ..... | ..... | ..... |
| Jarvis Ref. Co.: | | | | | | | | | |
| Troy (S) | 1,000 | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... |
| Johnson Oil Supply Corp.: | | | | | | | | | |
| Gary (S-C) | [1]6,000 | ..... | C [1]2,000 | ..... | ..... | ..... | ..... | ..... | ..... |
| R. J. Oil & Ref. Co., Inc.: | | | | | | | | | |
| Princeton (S) | [1]1,500 | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... |
| Rock Island Ref. Corp.: | | | | | | | | | |
| Rock Island (S-C) | 13,000 | ..... | ..... | F 5,600 | ..... | C [2]360 | ..... | ..... | ..... |
| Sinclair Ref. Co.: | | | | | | | | | |
| E. Chicago (Comp.) | 110,000 | 44,000 | C 15,000 | F 34,000 | ..... | C 2,450 | ..... | ..... | 3,500 |
| | ..... | ..... | R 13,000 | ..... | ..... | ..... | ..... | ..... | ..... |
| Socony-Vacuum Oil Co., Inc.: | | | | | | | | | |
| E. Chicago (S-C) | [3]37,500 | ..... | [4]9,500 | T 15,000 | ..... | ..... | ..... | ..... | ..... |
| Standard Oil Co. (Ind.): | | | | | | | | | |
| Whiting (Comp.) | 220,000 | 19,500 | C 42,000 | F 60,000 | Hy 14,000 | C 1,000 | 930 | S [1]700 | 6,680 |
| | ..... | ..... | V 14,000 | ..... | ..... | ..... | ..... | O [1]6,000 | ..... |
| | ..... | ..... | R 15,300 | ..... | ..... | ..... | ..... | M [1]225 | ..... |
| | ..... | ..... | Ck 41,000 | ..... | ..... | ..... | ..... | ..... | ..... |
| Total | 438,600 | 67,100 | 166,600 | 134,200 | 14,000 | 4,610 | 1,210 | 6,925 | 10,180 |

(1) Estimated. (2) Includes 60 bbl. per day to be added in 1953. (3) Includes 6,000 bbl. per day idle capacity. (4) Combination visbreaker-cracker plus polyformer.

## KANSAS

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Bay Pet. Corp., The: | | | | | | | | | |
| McPherson (S-C) | 6,000 | ..... | C 3,600 | ..... | ..... | T 200 | ..... | ..... | ..... |
| Coop. Refinery Association: | | | | | | | | | |
| Coffeyville (Comp.) | 25,000 | 5,500 | C 4,000 | F 5,500 | ..... | C 450 | ..... | S 1,500 | 1,500 |
| | ..... | ..... | R 1,000 | ..... | ..... | ..... | ..... | ..... | ..... |
| Phillipsburg (S-C-A) | [1]8,000 | [2]3,500 | ..... | F [2]4,500 | ..... | C [2]300 | ..... | S [2]600 | ..... |
| Derby Oil Co., The: | | | | | | | | | |
| Wichita (S-C-A) | 15,000 | 5,500 | C 3,000 | T 7,500 | ..... | C 450 | ..... | S 1,500 | ..... |
| El Dorado Ref. Co., The: | | | | | | | | | |
| El Dorado (S-C-A) | 12,000 | ..... | V 3,000 | F 5,000 | ..... | C 1,000 | ..... | S 1,200 | ..... |
| Kanotex Ref. Co.: | | | | | | | | | |
| Arkansas City (S-C-A) | 12,500 | 8,500 | C 3,500 | F 5,000 | ..... | C 500 | ..... | S 1,200 | ..... |
| M.F.A. Oil Co.: | | | | | | | | | |
| Chanute (S-C) | 2,000 | ..... | C 1,200 | ..... | Cy 1,000 | ..... | ..... | ..... | ..... |
| Natl. Coop. Refinery Association: | | | | | | | | | |
| McPherson (S-C) | 26,500 | 5,000 | C 2,500 | F 10,500 | ..... | C [2]900 | [2]225 | ..... | ..... |
| | ..... | ..... | V 10,000 | ..... | ..... | ..... | ..... | ..... | ..... |
| | ..... | ..... | Ck [2]10,000 | ..... | ..... | ..... | ..... | ..... | ..... |
| Phillips Pet. Co.: | | | | | | | | | |
| Kansas City (Comp.) | [4]55,000 | [4]15,000 | V [4]4,500 | F [4]30,000 | ..... | C [4]1,100 | ..... | S [4]1,500 | [4]2,000 |
| | ..... | ..... | R [4]7,800 | ..... | ..... | ..... | ..... | ..... | ..... |
| Shallow Water Ref. Co., The: | | | | | | | | | |
| Shallow Water (S-C-A) | 4,000 | 2,000 | C 1,300 | ..... | Cy 1,500 | ..... | ..... | S 1,000 | ..... |
| | ..... | ..... | ..... | ..... | ..... | ..... | ..... | M 300 | ..... |
| Skelly Oil Co.: | | | | | | | | | |
| El Dorado (S-C-A) | 40,000 | 12,000 | C 12,000 | F 16,000 | ..... | C 1,200 | ..... | S 2,500 | ..... |
| | ..... | ..... | R 5,000 | ..... | ..... | ..... | ..... | ..... | ..... |
| Socony-Vacuum Oil Co., Inc.: | | | | | | | | | |
| Augusta (S-C) | 28,500 | ..... | [6]9,000 | T 15,000 | ..... | ..... | ..... | ..... | ..... |
| Standard Oil Co. (Ind.): | | | | | | | | | |
| Neodesha (S-C-A) | 20,500 | ..... | C 5,400 | F [2]9,000 | ..... | ..... | 85 | M [5]500 | ..... |
| | ..... | ..... | R 2,600 | ..... | ..... | ..... | ..... | ..... | ..... |
| | ..... | ..... | Ck 5,100 | ..... | ..... | ..... | ..... | ..... | ..... |
| Vickers Pet. Co., Inc.: | | | | | | | | | |
| Potwin (S-C-A) | 10,000 | 5,000 | C 3,200 | T 6,000 | ..... | ..... | ..... | S 1,000 | ..... |
| | ..... | ..... | R 1,000 | ..... | ..... | ..... | ..... | ..... | ..... |
| Total | 265,000 | 62,000 | 98,700 | 140,000 | 2,500 | 6,100 | 310 | 12,800 | 3,500 |

(1) Includes 4,000 bbl. per day to be added in 1953. (2) New capacity to be placed in service during 1953. (3) Includes 200 bbl. per day to be added in 1953. (4) Barrels per calendar day basis. (5) Road-oil production. (6) Total thermal operations.

## KENTUCKY

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Ashland Oil & Ref. Co.: | | | | | | | | | |
| Catlettsburg (S-C-L) | 50,000 | 20,000 | C 6,000 | T [1]27,000 | ..... | C 1,500 | ..... | S 3,500 | [2]600 |
| | ..... | ..... | R 2,500 | ..... | ..... | ..... | ..... | O 3,500 | ..... |
| | ..... | ..... | ..... | ..... | ..... | ..... | ..... | M 1,500 | ..... |
| Louisville (S-C) | 9,500 | ..... | C 4,500 | ..... | ..... | ..... | ..... | ..... | ..... |
| Gilley Oil & Ref. Co.: | | | | | | | | | |
| Betsey Layne (S) | [3]300 | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... |
| Louisville Ref. Co.: | | | | | | | | | |
| Louisville (S-C) | 6,500 | 2,500 | C 2,500 | F 3,000 | ..... | C 400 | ..... | ..... | ..... |

## KENTUCKY (Continued)

| Company, plant location and type— | Capacity ratings: Charging, bbl. per stream day: Crude oil | Vacuum dist. | Thermal operations | Cat. cr. | Cat. ref. | Production: Poly. | Coke, tons per day | Asphalt | Lubes |
|---|---|---|---|---|---|---|---|---|---|
| Sohio Pet. Co.: | | | | | | | | | |
| Covington (S-C) | 18,000 | 12,000 | C 7,000 | | | C 450 | | O 3,500 | |
| | | | R 3,500 | | | | | | |
| Somerset Refinery: | | | | | | | | | |
| Somerset (S) | [3]2,000 | | | | | | | | |
| Total | 86,300 | 34,500 | 26,000 | 30,000 | | 2,350 | | 12,000 | 600 |

(1) Includes 3,000 bbl. daily to be added in 1953. (2) New capacity for service in 1953. (3) Estimated.

## LOUISIANA

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Bayou State Oil Corp.: | | | | | | | | | |
| Houston (S-L) | 1,000 | | | | | | | | 500 |
| Bay Pet. Corp., The: | | | | | | | | | |
| Chalmette (S-C) | [1]18,000 | 9,000 | V 9,000 | F 7,500 | | C 500 | | | |
| Breaux Bridge O. R. Co.: | | | | | | | | | |
| Breaux Bridge (S-C) | [2]1,600 | | | | | | | | |
| Calumet Ref. Co.: | | | | | | | | | |
| Princeton (S-L-A) | 900 | | | | | | | O 500 | 1,250 |
| Canal Ref. Co.: | | | | | | | | | |
| Church Point (S) | 1,500 | | | | | | | | |
| Cit-Con Oil Corp.: | | | | | | | | | |
| Lake Charles (L) | [3] | | | | | | | | 6,000 |
| Cities Service Ref. Corp.: | | | | | | | | | |
| Lake Charles (S-C) | [4]175,000 | | C 10,000 | F [5]86,000 | Hf [6]15,000 | | | | |
| Continental Oil Co.: | | | | | | | | | |
| Lake Charles (S-C) | [7]44,778 | | C 4,444 | T [6]17,028 | Pf [6]6,000 | T 667 | | | |
| | | | R 1,667 | | | C [8]585 | | | |
| Cotton Valley Solvents, Inc.: | | | | | | | | | |
| Cotton Valley (S) | [6]4,000 | | | | | | | | |
| Esso Standard Oil Co.: | | | | | | | | | |
| Baton Rouge (Comp.) | [9]312,000 | 91,000 | C [10]29,200 | F [11]153,200 | | C 4,300 | | S 8,300 | 8,500 |
| | | | V 19,000 | | | | | O 1,400 | |
| | | | R 14,900 | | | | | | |
| Evangeline Ref. Co., Inc.: | | | | | | | | | |
| Jennings (S-C) | [6]1,250 | | C [6]300 | | | | | | |
| Ingram Products Co.: | | | | | | | | | |
| Meraux (S-C) | [12]7,000 | | | F 3,000 | | ([13]) | | | |
| Pan-Am Southern Corp.: | | | | | | | | | |
| Destrehan (S-C) | 30,000 | | Ck 9,300 | F 15,000 | Hf 2,000 | | | | |
| Petco Corp.: | | | | | | | | | |
| Marrero (S-C) | [6]6,000 | | C [6]3,000 | | | | | | |
| | | | R [6]1,000 | | | | | | |
| Shell Oil Co.: | | | | | | | | | |
| Norco (S-C-A) | 50,000 | | C 22,500 | | | C 300 | | S 1,800 | |
| | | | R 2,000 | | | | | O 200 | |
| | | | | | | | | M 300 | |
| Stanolind Oil & Gas Co.: | | | | | | | | | |
| Superior (S-C) | [14]8,500 | | C 3,200 | | | C 190 | | | |
| | | | R 1,100 | | | | | | |
| Total | 661,528 | 100,000 | 130,611 | 281,728 | 23,000 | 6,542 | | 12,500 | 16,250 |

(1) Includes 2,000 bbl. per day to be added in 1953. (2) Combination topping-cracking operation. (3) Processes stock from outside sources to produce lubes and waxes. Through capacity 6,000 bbl. daily. (4) Includes 25,000 bbl. per day to be added in 1953. (5) Total charge. (6) New capacity to be in service during 1953. (7) Total capacity for service in 1953. (8) Estimated. (9) Includes 46,700 bbl. per day to be added in 1953. (10) Includes 6,200 bbl. per day to be added in 1953. (11) Total feed basis and includes 27,200 bbl. per day to be added in 1953. (12) Former Gilcrease Oil Co. plant, currently nonproductive due to expansion and modernization program. (13) Capacity suitable to balance operations of revised plant. (14) Includes 1,500 bbl. per day idle capacity.

## MARYLAND

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| American Bit. & Asphalt Co.: | | | | | | | | | |
| Baltimore (S-A) | [1]7,500 | | V [2]6,000 | | | | | S 6,000 | 250 |
| | | | | | | | | M 4,300 | |
| Esso Standard Oil Co.: | | | | | | | | | |
| Baltimore (S-C-A) | 60,000 | 14,000 | C 4,000 | F [3]32,000 | | | | S 7,800 | |
| | | | V 6,500 | | | | | O 1,400 | |
| Pan American Ref. Corp.: | | | | | | | | | |
| Baltimore (S) | 10,000 | | | | | | | | |
| Total | 77,500 | 14,000 | 16,500 | 32,000 | | | | 19,500 | 250 |

(1) Two-stage, vacuum-atmospheric operation. (2) Visbreaker operates only in December, January, and February for production of Bunker C fuel oil. (3) Total feed.

## MASSACHUSETTS

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Esso Standard Oil Co.: | | | | | | | | | |
| Everett (S-C-A) | [1]50,000 | [2]13,100 | V 10,000 | F [4]24,000 | | C [5]1,200 | | S 5,000 | |
| | | | R [3]5,150 | | | | | O 1,000 | |
| | | | | | | | | M 1,000 | |

(1) Includes 18,000 bbl. per day to be added in 1953. (2) New capacity. (3) Includes 1,150 bbl. per day to be added in 1953. (4) New capacity, total feed basis. (5) Includes 400 bbl. per day to be added in 1953.

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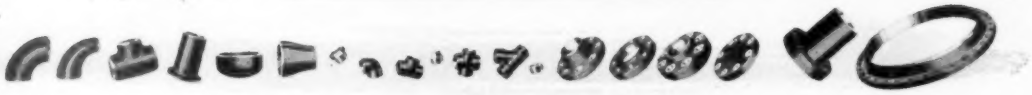

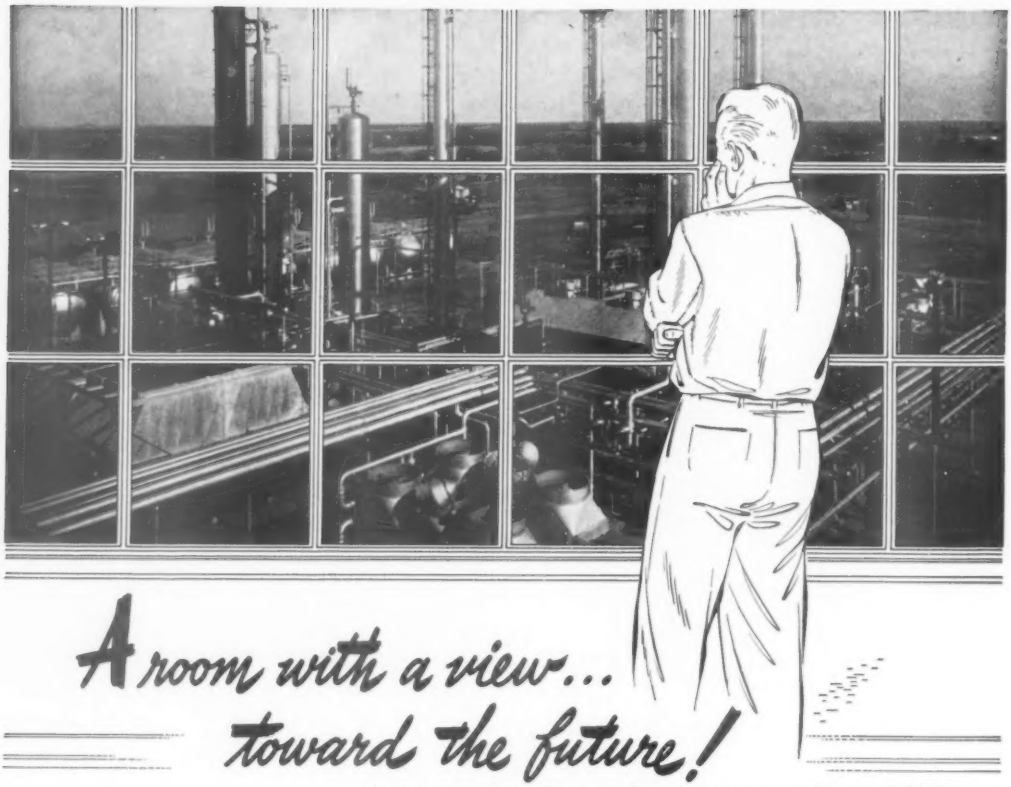

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Nordstrom Valves
Taylor Fittings and Flanges
Chapman Valves
Crane Valves

## MICHIGAN

| Company, plant location and type— | Capacity ratings: Charging, bbl. per stream day: Crude oil | Vacuum dist. | Thermal operations | Cat. cr. | Cat. ref. | Production: Poly. | Coke, tons per day | Asphalt | Lubes |
|---|---|---|---|---|---|---|---|---|---|
| Aurora Gasoline Co.: | | | | | | | | | |
| Detroit (S-C-A) | 35,000 | 15,000 | C 1,200 | F 10,000 | Pf [1]7,500 | C 450 | | S 4,000 | |
| | | | V 7,000 | | | | | | |
| | | | R 3,000 | | | | | | |
| Elsie | 6,000 | | | | Pf [2]1,500 | | | | |
| Bay Ref. Corp.: | | | | | | | | | |
| Bay City (S) | 10,500 | | | | | | | | |
| Crystal Ref. Co. of Carson City, Inc.: | | | | | | | | | |
| Carson City (S) | 6,200 | | | | | | | | |
| Lakeside Ref. Co.: | | | | | | | | | |
| Kalamazoo (S-C) | 3,500 | | [3]1,600 | | | | | | |
| Leonard Refs., Inc.: | | | | | | | | | |
| Alma (S-C-A) | 9,000 | | R 1,500 | T 7,000 | | | | S 800 | |
| Marvel Ref. Co.: | | | | | | | | | |
| Grand Rapids (S) | 2,000 | | | | | | | | |
| Mid-West Refineries, Inc.: | | | | | | | | | |
| Alma (S-C) | 10,000 | | C 3,600 | | Pf 2,200 | T 80 | | | |
| Naph-Sol Ref. Co.: | | | | | | | | | |
| Muskegon (S-C) | 5,000 | | | | | C 40 | | | |
| Old Dutch Ref. Co.: | | | | | | | | | |
| Muskegon (S-C) | 12,500 | | C 3,700 | | Pf 2,700 | C 100 | | | |
| Osceola Ref. Co., Inc.: | | | | | | | | | |
| Reed City (S) | 2,000 | | | | | | | | |
| Pet. Specialties, Inc.: | | | | | | | | | |
| Flat Rock (S-C) | 6,000 | | V 2,500 | | Pf 1,000 | | | | |
| Producers Ref., Inc.: | | | | | | | | | |
| West Branch (S-A) | 3,500 | 1,000 | | | | | | S 500 | |
| | | | | | | | | O 500 | |
| Pure Oil Co., The: | | | | | | | | | |
| Midland (S) | 4,700 | | | | | | | | |
| Roosevelt Oil & Ref. Corp.: | | | | | | | | | |
| Mount Pleasant (S-C) | 7,500 | | | | Cy 3,000 | | | | |
| Socony-Vacuum Oil Co., Inc.: | | | | | | | | | |
| Trenton (S-C) | 30,500 | | Ck 4,000 | T 15,000 | | | 145 | | |
| Total | 153,900 | 16,000 | 28,100 | 32,000 | 17,900 | 670 | 145 | 5,800 | |

(1) Includes 1,500 bbl. per day of added capacity to go into service in 1953. (2) New capacity for service in 1953. (3) New capacity to be placed in service in 1953. Operation includes combination cracking and visbreaking.

## MINNESOTA

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Northwestern Ref. Co.: | | | | | | | | | |
| New Brighton (S) | [1]4,000 | | | | | | | | |
| St. Paul Park (S-C-A) | [2]36,000 | [3]10,000 | | F [4]5,000 | | | | S [5]7,000 | |
| Total | 40,000 | 10,000 | | 5,000 | | | | 7,000 | |

(1) Includes 1,000 bbl. per day to be added in 1953. (2) Includes 30,000 bbl. per day to be added in 1953. (3) Under construction, to be placed in service in 1953. (4) Includes 5,000 bbl. per day to be added in 1953.

## MISSISSIPPI

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Paluxy Asphalt Co.: | | | | | | | | | |
| Crupp (S-C-A) | 5,500 | [1]1,000 | C 2,000 | | | C 200 | | S 500 | |
| | | | | | | | | O 500 | |
| The Southland Co.: | | | | | | | | | |
| Sandersville (S-A) | 5,500 | | | | | | | S 2,000 | |
| Total | 11,000 | 1,000 | 2,000 | | | 200 | | 3,000 | |

(1) Used in production of asphalts.

## MISSOURI

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Standard Oil Co. (Ind.): | | | | | | | | | |
| Sugar Creek (Comp.) | 73,000 | 7,200 | C 11,900 | F 32,000 | | C 1,800 | 505 | S 2,000 | |
| | | | R 6,000 | | | | | O 1,000 | |
| | | | Ck 30,400 | | | | | M 1,000 | |
| Total | 73,000 | 7,200 | 48,300 | 32,000 | | 1,800 | 505 | 4,000 | |

## MONTANA

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Big West Oil Co. of Montana: | | | | | | | | | |
| Kevin (S-C-A) | 2,200 | | C 1,200 | | | T 12 | | M 300 | |
| | | | R 250 | | | | | | |
| Carter Oil Co., The: | | | | | | | | | |
| Billings (S-C) | 22,000 | 4,480 | | F 11,000 | | C 600 | | | |
| Continental Oil Co.: | | | | | | | | | |
| Billings (S-C) | 8,889 | | | F 3,667 | | C 400 | | | |
| Farmers Union Cent. Exc., Inc.: | | | | | | | | | |
| Laurel (S-C-A) | 13,500 | | C 5,000 | F 7,000 | | C 600 | | S 4,000 | |
| | | | | | | | | M 1,500 | |

## MONTANA (Continued)

| Company, plant location and type— | Capacity ratings: Charging, bbl. per stream day: Crude oil | Vacuum dist. | Thermal operations | Cat. cr. | Cat. ref. | Production: Poly. | Coke, tons per day | Asphalt | Lubes |
|---|---|---|---|---|---|---|---|---|---|
| Phillips Pet. Co.: | | | | | | | | | |
| Great Falls (S-C-A) | [1]2,800 | [1]800 | C [1]1,200 | | | C [1]30 | | M [1]250 | |
| The Texas Co.: | | | | | | | | | |
| Sunburst (S-C) | 8,000 | | C 5,000 | | | | | | |
| Union Oil Co. of Calif.: | | | | | | | | | |
| Cutbank (S-C) | [1]3,600 | | C [1]1,900 | | | C [1]70 | | | |
| Unity Pet. Corp.: | | | | | | | | | |
| Kalispell (S-A) | 1,000 | | | | | | | S 600 | |
| Total | 61,989 | 5,280 | 14,550 | 21,667 | | 1,712 | | 6,650 | |

(1) Barrels per calendar basis.

## NEBRASKA

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Coop. Refinery Association: | | | | | | | | | |
| Scottsbluff (S-C) | 2,000 | | C 850 | | | | | | |
| Searle Pet. Co.: | | | | | | | | | |
| Salem (S) | 1,000 | | | | | | | | |
| Sioux Oil Co.: | | | | | | | | | |
| Chadron (S) | [1]600 | | | | | | | | |
| Total | 3,600 | | 850 | | | | | | |

(1) Estimated.

## NEW JERSEY

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| California Oil Co., The: | | | | | | | | | |
| Barber (S-C-A) | 64,000 | | V 5,000 | Ho 25,000 | | | | S 5,500 | |
| | | | R 10,000 | | | | | | |
| Cities Service Oil Co. (Pa.): | | | | | | | | | |
| Linden (S) | 15,000 | | | | | | | | |
| Esso Standard Oil Co.: | | | | | | | | | |
| Linden (S-C) | 148,000 | 50,000 | C 11,800 | F 94,000 | | C 4,000 | | | |
| | | | V 34,000 | | | | | | |
| | | | R 15,400 | | | | | | |
| Bayonne (S-L-A) | 35,000 | 10,000 | | | | | | S 8,200 | 6,000 |
| | | | | | | | | O 2,000 | |
| Socony-Vacuum Oil Co., Inc.: | | | | | | | | | |
| Paulsboro (Comp.) | 76,000 | | [1]9,200 | T [2]28,000 | | | | ([3]) | [4]7,000 |
| Texas Co., The: | | | | | | | | | |
| Westville (S-C) | 60,000 | | R 9,000 | F 30,000 | | C 2,500 | | | |
| Tide Water Associated Oil Co.: | | | | | | | | | |
| Bayonne (Comp.) | 87,500 | 10,300 | C 3,333 | T 11,111 | | T 3,889 | | | 2,400 |
| | | | R 3,222 | Hy 17,778 | | | | | |
| Total | 485,500 | 70,300 | 100,955 | 205,889 | | 10,389 | | 15,700 | 15,400 |

(1) Reforming and visbreaking. (2) Includes 15,000 bbl. per day to be added in 1953. (3) Not reported. (4) Estimated.

## NEW MEXICO

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Arex Co., The:[1] | | | | | | | | | |
| Bloomfield (S) | [2]750 | | | | | | | | |
| Continental Oil Co.: | | | | | | | | | |
| Artesia (S-C) | 3,778 | | C 1,611 | | | | | | |
| Farmington (S) | 833 | | | | | | | | |
| Famriss Oil & Ref. Co.: | | | | | | | | | |
| Monument (S-C) | [3]1,750 | | | | Pf [4]750 | | | | |
| Malco Refineries, Inc.: | | | | | | | | | |
| Prewitt (S-C) | 2,500 | | C 1,000 | | At 750 | | | | |
| Roswell | 2,500 | | C 1,000 | | | C 75 | | | |
| McNutt Oil & Ref. Co., Inc.: | | | | | | | | | |
| Brickland (S-C) | 3,500 | | C 1,200 | | Pf 650 | C 37 | | | |
| New Mexico Asphalt & Ref. Co.: | | | | | | | | | |
| Artesia (S-C-A) | 8,000 | | C 2,500 | F 6,000 | | C 300 | | S 1,500 | |
| Total | 23,611 | | 7,311 | 6,000 | 2,150 | 412 | | 1,500 | |

(1) Purchased by Malco Refineries, Inc. (2) New unit to be in operation by May 1953. (3) Includes 550 bbl. per day to be added in 1953. (4) New capacity to be in operation by late 1953.

## NEW YORK

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Frontier, Div. of Ashland O. & R. Co.: | | | | | | | | | |
| Tonawanda (S-C-A) | [1]25,000 | [2]10,000 | V [2]1,800 | F [2]10,000 | | C [3]825 | | S 2,000 | |
| | | | R 3,000 | | | | | O 2,000 | |
| Gulf Oil Corp.: | | | | | | | | | |
| Staten Is. (S) | [3]17,000 | | | | | | | | |
| Sinclair Ref. Co.: | | | | | | | | | |
| Wellsville (S-C-L) | 9,000 | 3,000 | C 5,000 | | | | | | 2,500 |
| | | | R 3,000 | | | | | | |

## NEW YORK (Continued)

| Company, plant location and type— | Capacity ratings: Charging, bbl. per stream day: Crude oil | Vacuum dist. | Thermal operations | Cat. cr. | Cat. ref. | Production: Poly. | Coke, tons per day | Asphalt | Lubes |
|---|---|---|---|---|---|---|---|---|---|
| Socony-Vacuum Oil Co., Inc.: | | | | | | | | | |
| Brooklyn (S-C) | 26,500 | ..... | ..... | T 15,000 | ..... | (4) | ..... | ..... | ..... |
| Buffalo (Comp.) | 25,500 | ..... | R 5,500 | T 15,000 | ..... | (4) | ..... | (4) | 1,000 |
| Olean (S-L) | 7,000 | ..... | ..... | ..... | ..... | ..... | ..... | ..... | 1,200 |
| Total | 110,000 | 13,000 | 18,300 | 40,000 | ..... | 825 | ..... | 4,000 | 4,700 |

(1) Includes 5,000 bbl. per day to be added in 1953. (2) New capacity for service in 1953. (3) Includes 7,000 bbl. per day to be added in 1953. (4) Not reported. (5) Barrels per calendar day.

## OHIO

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Ashland Oil & Ref. Co.: | | | | | | | | | |
| Canton (S-C) | 25,000 | 5,000 | V 10,000 | F 12,000 | ..... | C 550 | ..... | ..... | ..... |
| Findlay (Comp.) | [1]15,000 | [2]11,000 | C 4,500 | ..... | ..... | T 175 | ..... | [3]1,400 | 600 |
| | ..... | ..... | R 1,500 | ..... | ..... | ..... | ..... | [3]1,400 | ..... |
| | ..... | ..... | ..... | ..... | ..... | ..... | ..... | [4]250 | ..... |
| Dewese Oil Refinery: | | | | | | | | | |
| Weston (S-L) | [5]1,750 | 400 | ..... | ..... | ..... | ..... | ..... | ..... | 400 |
| Gulf Ref. Co.: | | | | | | | | | |
| Cleves (S-C) | [6]30,000 | ..... | C [6]12,300 | F [6]12,000 | ..... | C [6]1,500 | ..... | ..... | ..... |
| Toledo (S-C) | [6]40,000 | ..... | C [6]12,200 | F [6]12,000 | ..... | C [6]1,500 | ..... | ..... | ..... |
| Pure Oil Co., The: | | | | | | | | | |
| Newark (S-C) | 15,500 | ..... | [7]9,000 | F 4,500 | ..... | C 200 | ..... | ..... | ..... |
| Toledo (S-C) | 29,400 | ..... | [7]19,700 | F [4]11,600 | Hy 5,000 | C [4]1,270 | 175 | ..... | ..... |
| | ..... | ..... | Ck 6,600 | ..... | ..... | ..... | ..... | ..... | ..... |
| Standard Oil Co. (Ohio): | | | | | | | | | |
| Cleveland (Comp.) | 50,000 | 16,500 | C 12,000 | T 18,000 | ..... | C 700 | ..... | O 7,000 | 1,200 |
| | ..... | ..... | R 10,000 | ..... | ..... | ..... | ..... | ..... | ..... |
| Lima (Comp.) | 43,000 | 11,000 | C 5,000 | F 25,000 | ..... | C 600 | 320 | ..... | 1,500 |
| Toledo (S-C) | 25,000 | ..... | C 7,500 | ..... | ..... | C 500 | 160 | ..... | ..... |
| | ..... | ..... | R 6,500 | ..... | ..... | ..... | ..... | ..... | ..... |
| | ..... | ..... | Ck 7,000 | ..... | ..... | ..... | ..... | ..... | ..... |
| Sun Oil Co.: | | | | | | | | | |
| Toledo (S-C) | 72,000 | ..... | C 17,000 | Hy 15,000 | Pf 15,000 | C 2,700 | ..... | ..... | ..... |
| | ..... | ..... | ..... | Ho 28,000 | ..... | ..... | ..... | ..... | ..... |
| Total | 346,650 | 43,900 | 140,800 | 138,100 | 20,000 | 9,695 | 655 | 7,000 | 3,700 |

(1) Includes 1,000 bbl. per day to be added in 1953. (2) Includes 8,000 bbl. per day to be added in 1953. (3) Includes 700 bbl. per day to be added in 1953. (4) New capacity to be in service during 1953. (5) Includes 400 bbl. per day idle capacity. (6) Barrels per calendar day. (7) Total for all thermal operations.

## OKLAHOMA

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Allied Materials Corp.: | | | | | | | | | |
| Stroud (S-A) | 2,000 | 1,000 | ..... | ..... | ..... | ..... | ..... | S 1,000 | ..... |
| | ..... | ..... | ..... | ..... | ..... | ..... | ..... | O 1,000 | ..... |
| Anderson-Prichard Oil Corp.: | | | | | | | | | |
| Cyril (S-C-A) | 10,000 | ..... | C 5,000 | ..... | ..... | ..... | ..... | S 1,200 | ..... |
| | ..... | ..... | ..... | ..... | ..... | ..... | ..... | O 500 | ..... |
| Bell Oil & Gas Co.: | | | | | | | | | |
| Grandfield (S-C-L) | 7,000 | ..... | C 4,000 | ..... | Pf [1]2,200 | C 150 | ..... | ..... | 150 |
| Ben Franklin Ref. Co.: | | | | | | | | | |
| Ardmore (S-C) | [2]12,000 | [3]7,000 | C 4,500 | F [3]6,000 | ..... | T [4]600 | ..... | M [3]1,100 | ..... |
| | ..... | ..... | Ck [3]5,000 | ..... | ..... | ..... | ..... | ..... | ..... |
| Champlin Ref. Co.: | | | | | | | | | |
| Enid (Comp.) | 20,000 | 7,000 | C 7,000 | ..... | ..... | C 450 | ..... | ..... | 1,500 |
| | ..... | ..... | R 3,500 | ..... | ..... | ..... | ..... | ..... | ..... |
| Cities Service Oil Co. (Del.): | | | | | | | | | |
| Ponca City (S-C) | 21,000 | 7,800 | C 800 | F 10,000 | ..... | ..... | 100 | ..... | ..... |
| | ..... | ..... | R 1,950 | ..... | ..... | ..... | ..... | ..... | ..... |
| | ..... | ..... | Ck 1,950 | ..... | ..... | ..... | ..... | ..... | ..... |
| Continental Oil Co.: | | | | | | | | | |
| Ponca City (Comp.) | 58,333 | 11,639 | C 10,000 | T [5]19,167 | Hf 3,333 | C 690 | 370 | ..... | 2,222 |
| | ..... | ..... | V 2,222 | ..... | ..... | ..... | ..... | ..... | ..... |
| | ..... | ..... | R 2,222 | ..... | ..... | ..... | ..... | ..... | ..... |
| | ..... | ..... | Ck 8,000 | ..... | ..... | ..... | ..... | ..... | ..... |
| Deep Rock Oil Corp.: | | | | | | | | | |
| Cushing (Comp.) | 19,000 | 2,750 | ..... | F 6,200 | ..... | C 50 | ..... | S 300 | 1,050 |
| Johnson Oil Ref. Co.: | | | | | | | | | |
| Cleveland (S-C) | 6,300 | ..... | C 2,750 | ..... | Pf 1,800 | (6) | ..... | ..... | ..... |
| Kerr-McGee Oil Industries, Inc.: | | | | | | | | | |
| Wynnewood (S-C-A) | [7]12,000 | [6]6,000 | V 2,000 | ..... | ..... | ..... | ..... | S 4,000 | ..... |
| Mercury Oil Ref. Co.: | | | | | | | | | |
| Oklahoma City (S-C) | 3,500 | ..... | C 1,450 | ..... | ..... | ..... | ..... | ..... | ..... |
| Mid-Continent Pet. Corp.: | | | | | | | | | |
| Tulsa (Comp.) | 60,500 | ..... | C 3,500 | F [10]26,500 | ..... | C 1,500 | ..... | S 1,000 | 6,000 |
| | ..... | ..... | V 5,000 | ..... | ..... | ..... | ..... | ..... | ..... |
| | ..... | ..... | R 6,000 | ..... | ..... | ..... | ..... | ..... | ..... |

## OKLAHOMA (Continued)

| Company, plant location and type | Capacity ratings: Charging, bbl. per stream day: Crude oil | Vacuum dist. | Thermal operations | Cat. cr. | Cat. ref. | Production: Poly. | Coke, tons per day | Asphalt | Lubes |
|---|---|---|---|---|---|---|---|---|---|
| Midland Coop. Wholesale: | | | | | | | | | |
| Cushing (S-C) | [11]10,500 | | V [2]5,000 | F [2]5,000 | | C [13]400 | | | |
| Monarch Refineries, Inc.: | | | | | | | | | |
| Oklahoma City (S-A) | 1,000 | | | | | | | M 1,000 | |
| Peppers Ref. Co.: | | | | | | | | | |
| Oklahoma City (S-C) | [12]2,000 | | C [13]1,600 | | | | | | |
| Phillips Pet. Co.: | | | | | | | | | |
| Okmulgee (S-C-A) | [14]12,000 | [14]3,000 | V [14]2,800 | T [14]8,000 | | C [14]450 | | M [14]200 | |
| Sunray Oil Corp.: | | | | | | | | | |
| Allen (S-C) | [15]13,000 | | C 9,000 | | | C 250 | | | |
| Duncan (S-C-A) | 33,600 | 13,000 | V 2,500 | F 13,000 | | C 350 | | S 1,000 | |
| Texas Co., The: | | | | | | | | | |
| Tulsa | 35,000 | | C 9,000 | F 15,000 | | C 1,500 | | | |
| | | | R 5,000 | | | | | | |
| Tide Water Associated Oil Co.: | | | | | | | | | |
| Drumright (S-C) | [16]15,000 | [17]7,000 | | Ho 4,500 | | C 350 | | | |
| Wilcox Oil Co.: | | | | | | | | | |
| Bristow (S-C) | [2]5,000 | | C 2,250 | | Pf 1,500 | C 150 | | | |
| Total | 358,733 | 66,189 | 113,994 | 113,367 | 8,833 | 6,890 | 470 | 12,300 | 10,922 |

(1) Includes 400 bbl. per day to be added in 1953. (2) Includes 2,000 bbl. per day to be added in 1953. (3) New capacity to be placed in service during 1953. (4) Includes 500 bbl. per day to be added in 1953. (5) Fresh feed. (6) Not reported. (7) Includes 2,000 bbl. per day to be added in 1953. (8) Includes 1,000 bbl. per day to be added in 1953. (9) Includes 500 bbl. per day of idle capacity. (10) Includes 6,500 bbl. per day to be added in 1953. (11) Includes 4,500 bbl. per day to be added in 1953. (12) Includes 350 bbl. per day to be added in 1953. (13) Estimated. (14) Barrels per calendar day. (15) Includes 9,000 bbl. per day charged to thermal cracker and 4,000 bbl. per day of idle topping capacity. (16) Includes 4,000 bbl. per day to be added in 1953. (17) Includes 2,000 bbl. per day to be added in 1953.

## OREGON

| Company, plant location and type | Crude oil | Vacuum dist. | Thermal operations | Cat. cr. | Cat. ref. | Poly. | Coke, tons per day | Asphalt | Lubes |
|---|---|---|---|---|---|---|---|---|---|
| American Bit. & Asphalt Co.: | | | | | | | | | |
| Portland (S-A) | [1]6,500 | | | | | | | S 4,200 | |
| | | | | | | | | O 900 | |
| | | | | | | | | M 1,150 | |
| Total | 6,500 | | | | | | | 6,250 | |

(1) Operates in primary distillation of crude oil.

## PENNSYLVANIA

| Company, plant location and type | Crude oil | Vacuum dist. | Thermal operations | Cat. cr. | Cat. ref. | Poly. | Coke, tons per day | Asphalt | Lubes |
|---|---|---|---|---|---|---|---|---|---|
| Atlantic Ref. Co.: | | | | | | | | | |
| Philadelphia (Comp.) | [1]142,900 | | C [2]13,500 | F [2]30,000 | At [3]10,000 | C [3]1,900 | | S [2]2,000 | [2]5,000 |
| | | | R [2]15,000 | | | | | O [2]700 | |
| | | | | | | | | M [2]1,500 | |
| Freedom, Div. of Ashland O. & R. Co.: | | | | | | | | | |
| Freedom (S-L) | 4,750 | 2,300 | C 500 | | | T 30 | | | 1,000 |
| | | | R 500 | | | | | | |
| Gulf Oil Corp.: | | | | | | | | | |
| Neville Is. (S-C) | [2]13,000 | | C [2]6,000 | | | | | | |
| Philadelphia (Comp.) | [2]107,000 | | C [2]31,200 | F [2]60,000 | Pf [2]30,000 | C [2]3,600 | | | [2]1,000 |
| Kendall Ref. Co.: | | | | | | | | | |
| Bradford (Comp.) | 5,000 | 300 | C 1,500 | F 1,500 | Pf 1,500 | C 100 | | | 1,200 |
| Pennsylvania Ref. Co.: | | | | | | | | | |
| Karns City (S-L) | 2,000 | | | | | | | | 600 |
| Pennzoil Co., The: | | | | | | | | | |
| Rouseville (Comp.) | 8,500 | | C [4]1,250 | F [4]2,810 | | T 750 | | | 2,500 |
| | | | R [4]4,450 | | | | | | |
| Quaker Oil Ref. Corp.: | | | | | | | | | |
| Emlenton (S-C-L) | 2,000 | | C 1,350 | | | | | | 1,700 |
| Farmers Valley (S-C-L) | 4,000 | | C 1,350 | | | | | | 2,300 |
| Oil City (S-C-L) | 2,800 | | C 1,230 | F [4]1,070 | | | | | 600 |
| Sinclair Ref. Co.: | | | | | | | | | |
| Marcus Hook (S-C) | 100,000 | 45,000 | C 11,000 | F 34,000 | | C 1,850 | | | |
| | | | R 8,000 | | | | | | |
| | | | V 9,000 | | | | | | |
| Sonneborn, L., Sons, Inc.: | | | | | | | | | |
| Franklin (S-L) | 2,000 | | | | | | | | 500 |
| Petrolia (S-L) | 4,000 | | | | | | | | 1,000 |
| Sun Oil Co.: | | | | | | | | | |
| Marcus Hook (Comp.) | [2]145,000 | [2]14,500 | R [2]24,000 | T [2]22,000 | H [2]10,000 | C 2,500 | | O [2]1,000 | [2]12,000 |
| | | | | Hy [2]68,500 | | | | | |
| United Ref. Co.: | | | | | | | | | |
| Warren (S-C-L) | 5,500 | | C 2,200 | | At [5]2,500 | T 100 | | | 1,600 |
| Wolf's Head Oil Ref. Co.: | | | | | | | | | |
| Reno (S-C-L) | 2,500 | | C [4]360 | F [4]620 | | | | | [6]650 |
| | | | R [4]360 | | | | | | |
| Total | 550,950 | 62,100 | 132,750 | 220,500 | 54,000 | 10,830 | | 5,200 | 31,650 |

(1) Barrels per calendar day and includes 19,400 bbl. per day to be added in 1953. (2) Barrels per calendar day. (3) Barrels per calendar day. New capacity to be added in 1953. (4) Portion of jointly owned facilities. (5) Barrels per calendar day and includes 900 bbl. per day to be added in 1953. (5) New capacity to be in service during 1953. (6) Estimated.

## RHODE ISLAND

| Company, plant location and type— | Capacity ratings: Charging, bbl. per stream day: Crude oil | Vacuum dist. | Thermal operations | Cat. cr. | Cat. ref. | Production: Poly. | Coke, tons per day | Asphalt | Lubes |
|---|---|---|---|---|---|---|---|---|---|
| American Bit. & Asphalt Co.: | | | | | | | | | |
| E. Providence (S-A) | 1,500 | | | | | | | S 750 | |
| | | | | | | | | M 1,150 | |
| Socony-Vacuum Oil Co., Inc.: | | | | | | | | | |
| E. Providence (S-A) | 8,500 | | | | | | | (1) | |
| Texas Co., The: | | | | | | | | | |
| Providence (S-A) | 3,500 | | | | | | | S [2]1,500 | |
| Total | 13,500 | | | | | | | 3,400 | |

(1) Not reported. (2) Estimated.

## SOUTH CAROLINA

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Esso Standard Oil Co.: | | | | | | | | | |
| Charleston (S-A) | 8,000 | 6,400 | | | | | | S 4,000 | |
| | | | | | | | | O 500 | |
| Total | 8,000 | 6,400 | | | | | | 4,500 | |

## SOUTH DAKOTA

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Hot Springs Ref. Co.: | | | | | | | | | |
| Hot Springs (S) | 200 | | | | | | | | |

## TENNESSEE

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Delta Ref. Co.: | | | | | | | | | |
| Memphis (S-C) | [1]6,000 | | C 1,200 | T [2]2,700 | | | | | |
| Southern Oil Service: | | | | | | | | | |
| Nashville (S) | 1,000 | | | | | | | | |
| Total | 7,000 | | 1,200 | 2,700 | | | | | |

(1) Includes 2,000 bbl. per day to be added in 1953. (2) Under construction, to be placed in service in 1953.

## TEXAS

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| American Liberty Oil Co.: | | | | | | | | | |
| Mount Pleasant (S-C-A) | 17,000 | [1]10,800 | C 4,000 | T [2]5,120 | | C [3]400 | | S 6,000 | |
| | | | V [2]3,000 | | | | | | |
| | | | R 500 | | | | | | |
| Atlantic Ref. Co.: | | | | | | | | | |
| Port Arthur (S-L) | [4]61,000 | | | F [4]26,000 | | C [4]100 | | | |
| Bryson P. L. & Ref. Co.: | | | | | | | | | |
| Bryson (S-L) | 2,000 | | | | | | | | 300 |
| Col-Tex Ref. Co.: | | | | | | | | | |
| Colorado City (S-C-A) | [5]10,000 | 6,000 | C 3,000 | | Pf [2]1,500 | C 80 | | S 1,500 | |
| | | | R 300 | | | | | O 500 | |
| Continental Oil Co.: | | | | | | | | | |
| Wichita Falls (S-C) | 7,778 | | C 3,556 | | | T 556 | | | |
| | | | R 1,333 | | | C 167 | | | |
| Cosden Pet. Corp.: | | | | | | | | | |
| Big Spring (S-C-A) | 25,000 | 10,000 | C 8,000 | F [6]10,000 | Pf 4,500 | C [7]900 | | O 3,500 | |
| Crown Central Pet. Corp.: | | | | | | | | | |
| Houston (S-C-L) | [9]25,000 | | C [8]8,000 | T [9]17,500 | | | | | [9]1,000 |
| | | | R [9]1,200 | | | | | | |
| Danaho Ref. Co.: | | | | | | | | | |
| Pettus (S-C) | [8]4,000 | | C 1,200 | | | C 50 | | | |
| Eastern States Pet. Co., Inc.: | | | | | | | | | |
| Houston (S-C) | 50,000 | 22,000 | C 5,000 | F 16,500 | Pf 5,600 | C 1,000 | | | |
| | | | V 14,000 | | | | | | |
| Eddy Ref. Co.: | | | | | | | | | |
| Houston (S) | 2,500 | | | | | | | | |
| Gladewater Ref. Corp.: | | | | | | | | | |
| Gladewater (S-C) | [9]2,500 | | C [9]2,000 | | | C [9]90 | | | |
| Great Southern Corp.: | | | | | | | | | |
| Corpus Christi (C) | | | C 4,000 | | Pf 4,000 | | | | |
| Gulf Oil Corp.: | | | | | | | | | |
| Fort Worth (S-C) | [4]8,500 | | C [4]4,000 | | | | | | |
| Port Arthur (Comp.) | [4]245,000 | [4]25,000 | C [4]84,200 | F [4]54,000 | Pf [2]30,000 | C [2]3,600 | | | [4]12,000 |
| | | | | T 25,000 | | | | | |
| | | | | Hy 9,000 | | | | | |
| Sweetwater (S-C) | [4]7,500 | | C [4]4,000 | | | | | | |
| Humble Oil & Ref. Co.: | | | | | | | | | |
| Baytown (Comp.) | [10]292,000 | | C [11]54,000 | F [11]101,000 | Hy 27,000 | T 3,700 | | S 2,500 | 12,700 |
| | | | R [11]5,000 | | | | | | |
| Inland Ref. Co., Inc.: | | | | | | | | | |
| Palestine (S-C) | [9]2,000 | | C [9]1,000 | | | T [9]100 | | | |
| | | | R 750 | | | | | | |
| Lacy, R., Inc.: | | | | | | | | | |
| Big Sandy (S-C) | 4,000 | | C 1,000 | | Cy 1,000 | C 50 | | S 1,000 | |
| Magnolia Pet. Co.: | | | | | | | | | |
| Beaumont (Comp.) | [4]170,000 | [4]23,000 | C [4]5,000 | T [4]67,000 | | T [4]2,000 | | | 6,000 |
| | | | V [4]50,000 | Hy [4]11,000 | | | | | |
| | | | R [4]11,000 | | | | | | |

**TEXAS (Continued)**

| Company, plant location and type | Capacity ratings: Charging, bbl. per stream day: Crude oil | Vacuum dist. | Thermal operations | Cat. cr. | Cat. ref. | Production: Poly. | Coke, tons per day | Asphalt | Lubes |
|---|---|---|---|---|---|---|---|---|---|
| Fort Worth (S-C) | [4]12,000 | | C [4]7,500 | | | C [4]1,700 | [4]90 | | |
| | | | R [4]1,800 | | | | | | |
| | | | Ck [4]5,300 | | | | | | |
| McBride Ref. Co.: | | | | | | | | | |
| La Blanca (S-C) | 2,500 | | | | At 1,000 | | | | |
| McMurrey Ref. Co.: | | | | | | | | | |
| Tyler (S-C) | [9]10,000 | [9]5,000 | C [9]1,750 | F [9]4,100 | | C [9]800 | | | |
| Monarch Ref. Co.: | | | | | | | | | |
| San Antonio (S) | 2,000 | | | | | | | | |
| Onyx Ref. Co.: | | | | | | | | | |
| Abilene (S-C) | [9]6,000 | | C [9]5,500 | | | | | | |
| Pan American Ref. Corp.: | | | | | | | | | |
| Texas City (S-C) | [13]135,500 | | C 85,000 | F [14]68,000 | Hy 7,500 | | | | |
| | | | R 10,500 | | | | | | |
| Panhandle Oil Corp.: | | | | | | | | | |
| Wichita Falls (S-C) | 8,000 | | C 1,750 | F 1,500 | | C 120 | | | |
| Patton Oil Co.: | | | | | | | | | |
| Rotan (S) | [9]1,500 | | | | | | | | |
| Peerless Tank Cleaning Co.: | | | | | | | | | |
| Kilgore (S) | [9]1,000 | | | | | | | | |
| Pet. Products R. & P. Co.: | | | | | | | | | |
| Lueders (S) | 1,400 | | | | | | | | |
| Petrolite Corp.: | | | | | | | | | |
| Kilgore (S) | [9]700 | | | | | | | | |
| Phillips Oil Co.: | | | | | | | | | |
| Phillips (S-C) | [4]70,000 | [4]17,000 | C [4]7,200 | F [4]35,000 | | C [2]250 | | | |
| | | | V [4]7,200 | Cy [4]11,000 | | | | | |
| | | | R [4]27,000 | | | | | | |
| Sweeny (S-C) | [4]70,000 | [4]17,000 | C [4]5,000 | F [4]26,000 | | | | | |
| Phoenix Ref. Co.: | | | | | | | | | |
| San Antonio (S) | 3,500 | | | | | | | | |
| Pontiac Ref. Corp.: | | | | | | | | | |
| Corpus Christi (S-C) | [9]30,000 | | | F [9]6,000 | | | | | |
| Port Fuel Co., Inc.: | | | | | | | | | |
| Brownsville (S) | 6,000 | [2]1,500 | | | | | | | |
| Premier Pet. Co.: | | | | | | | | | |
| Arp (S-C) | 5,000 | | C 3,000 | | | C 85 | | | |
| Baird (S-C) | 2,500 | | C 1,200 | | | | | | |
| Fort Worth (S-C) | 7,800 | | C 2,100 | | Pf 1,700 | | | | |
| Longview (S-C) | 4,200 | | C 1,600 | | | C [2]90 | | | |
| Pure Oil Co., The: | | | | | | | | | |
| Nederland (Comp.) | [15]67,000 | | [16]15,200 | F [2]17,750 | | T 800 | | | 2,000 |
| | | | | T 9,800 | | C [2]825 | | | |
| Rado Ref. Co.: | | | | | | | | | |
| McAllen (S) | [17]2,800 | | | | | | | | |
| Republic Oil Ref. Co.: | | | | | | | | | |
| Texas City (S-C) | 40,000 | 15,000 | C 10,000 | F 15,000 | Pf [2]5,500 | C 1,000 | | | |
| Shamrock O. & G. Corp., The: | | | | | | | | | |
| Sunray (S-C-A) | 15,000 | | C 5,000 | Ho 5,900 | | C 550 | | S [2]250 | |
| | | | | Cy 1,500 | | | | | |
| Shell Oil Co.: | | | | | | | | | |
| Houston (Comp.) | 125,000 | | C 34,000 | F 35,000 | Pf [2]12,000 | | | S 500 | 3,000 |
| | | | R 17,000 | | | | | | |
| Sid Richardson Ref. Co.: | | | | | | | | | |
| Texas City (S-C) | 16,500 | | C 8,000 | | | | | | |
| Sinclair Ref. Co.: | | | | | | | | | |
| Corpus Christi (S-C) | 28,000 | | C 7,000 | Hy 12,000 | | | | | |
| | | | V 3,000 | | | | | | |
| Houston (Comp.) | [18]125,000 | [18]43,000 | C 27,000 | F [2]40,000 | | | | | 3,500 |
| | | | R 11,000 | T 10,000 | | | | | |
| | | | | Hy 12,000 | | | | | |
| Skelly Oil Co.: | | | | | | | | | |
| Longview (S-C) | 6,500 | | C 3,300 | | Pf 1,800 | C 100 | | | |
| Southwestern O. & R. Co.: | | | | | | | | | |
| Corpus Christi (S-C) | [9]30,000 | | C [9]1,000 | F [9]5,000 | | | ([19]) | | |
| Standard Oil Co. of Texas: | | | | | | | | | |
| El Paso (S-C) | [20]28,000 | 7,555 | C 8,000 | Ho 11,500 | | | | | |
| Suntide Ref. Co.: | | | | | | | | | |
| Corpus Christi (S-C) | [2]30,000 | [2]10,000 | | F [2]15,000 | | C [2]2,000 | | | |
| Taylor Oil & Gas Co.: | | | | | | | | | |
| Corpus Christi (S-C) | [20]40,000 | | V [2]2,000 | T 10,000 | Pf [2]5,250 | C 600 | | | |
| | | | R 2,500 | | | | | | |
| Port Isabel (S-C) | [21]15,000 | | | | Pf 4,250 | | | | |
| Texas City Ref., Inc.: | | | | | | | | | |
| Texas City (S-C) | 40,000 | | V [3]3,750 | Hy 10,000 | | | | | |
| | | | | Ho [2]17,500 | | | | | |
| Texas Co., The: | | | | | | | | | |
| Amarillo (S-C) | 8,500 | | Ck 4,000 | | | C 150 | 100 | | |
| El Paso (S-C) | 5,500 | | C 3,000 | | | | | | |

## TEXAS (Continued)

| Company, plant location and type | Capacity ratings: Charging, bbl. per stream day — Crude oil | Vacuum dist. | Thermal operations | Cat. cr. | Cat. ref. | Poly. | Production: Coke, tons per day | Asphalt | Lubes |
|---|---|---|---|---|---|---|---|---|---|
| Port Arthur (Comp.) | [22]210,000 | ..... | C 102,000 | F 60,000 | ..... | C 3,000 | 200 | ..... | [9]16,000 |
| | ..... | ..... | R 12,000 | ..... | ..... | ..... | ..... | ..... | ..... |
| | ..... | ..... | Ck 7,000 | ..... | ..... | ..... | ..... | ..... | ..... |
| Port Neches (S-A) | 40,000 | ..... | ..... | ..... | ..... | ..... | ..... | S 5,000 | ..... |
| Three Rivers Refinery: | | | | | | | | | |
| Three Rivers (S-L-A) | 1,500 | ..... | ..... | ..... | ..... | ..... | ..... | ([19]) | 1,500 |
| Tydal Co.: | | | | | | | | | |
| Gainesville (S-C) | [9]1,800 | ..... | C [9]400 | ..... | ..... | ..... | ..... | ..... | ..... |
| Ute Oil & Ref. Co.: | | | | | | | | | |
| Graham (S) | [9]700 | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... |
| W. T. Waggoner Estate: | | | | | | | | | |
| Electra (S-C) | 5,000 | ..... | C 2,500 | ..... | ..... | ..... | ..... | ..... | ..... |
| Wickett Ref. Co.: | | | | | | | | | |
| Wickett (S-C) | [9]3,000 | ..... | C [9]2,000 | ..... | ..... | ..... | ..... | ..... | ..... |
| Total | 2,200,178 | 212,855 | 743,089 | 781,670 | 112,600 | 24,863 | 390 | 20,750 | 58,000 |

(1) Includes 1,800 bbl. per day to be added in 1953. (2) New capacity to be added in 1953. (3) Includes 150 bbl. per day to be added in 1953. (4) Barrels per calendar day basis. (5) Includes 2,000 bbl. per day of idle capacity. (6) Includes 2,000 bbl. per day to be added in 1953. (7) Includes 200 bbl. per day to be added in 1953. (8) Includes 500 bbl. per day to be added in 1953. (9) Estimated. (10) Includes 32,000 bbl. per day of current idle capacity which is scheduled for service during late 1953. (11) Fresh feed. (12) Type of cat cracker not reported. (13) Includes 3,000 bbl. per day to be added in 1953. (14) Includes 30,000 bbl. per day to be added in 1953. (15) Includes 12,000 bbl. per day to be added in 1953. (16) Total thermal operations. (17) Includes 800 bbl. per day to be added in 1953. (18) Includes 35,000 bbl. per day to be added in 1953. (19) Not reported. (20) Includes 3,000 bbl. per day of idle capacity. (21) Includes 5,000 bbl. per day of idle capacity. (22) Includes 40,000 bbl. per day of pressure distillation.

## UTAH

| Company, plant location and type | Crude oil | Vacuum dist. | Thermal operations | Cat. cr. | Cat. ref. | Poly. | Coke, tons per day | Asphalt | Lubes |
|---|---|---|---|---|---|---|---|---|---|
| Phillips Pet. Co.: | | | | | | | | | |
| Woods Cross (S-C-A-) | [1]10,000 | [1]3,000 | ..... | T [1]8,000 | ..... | C [1]250 | ..... | S [1]800 | ..... |
| Salt Lake Ref. Co.: | | | | | | | | | |
| Salt Lake City (S-C) | 27,000 | 9,000 | ..... | Ho 13,000 | ..... | ..... | ..... | ..... | ..... |
| Uinta Oil Ref. Co.: | | | | | | | | | |
| Jensen (S) | 1,500 | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... |
| Utah Oil Ref. Co.: | | | | | | | | | |
| Salt Lake City (Comp.) | [2]28,000 | ..... | C 7,200 | F 16,000 | ..... | ..... | ..... | ..... | 120 |
| Western States Ref. Co.: | | | | | | | | | |
| N. Salt Lake City (S-C) | [3]3,000 | ..... | C 500 | ..... | ..... | ..... | ..... | ..... | ..... |
| Total | 69,500 | 12,000 | 7,700 | 37,000 | ..... | 250 | ..... | 800 | 120 |

(1) Barrels per calendar day basis. (2) Includes 1,000 bbl. per day to catalytic cracker. (3) Includes 1,000 bbl. per day to be added during 1953.

## WASHINGTON

| Company, plant location and type | Crude oil | Vacuum dist. | Thermal operations | Cat. cr. | Cat. ref. | Poly. | Coke, tons per day | Asphalt | Lubes |
|---|---|---|---|---|---|---|---|---|---|
| American Bit. & Asphalt Co.: | | | | | | | | | |
| Richmond Beach (S-A) | [1]3,500 | ..... | ..... | ..... | ..... | ..... | ..... | S 2,600 | ..... |
| Phillips Pet. Co.: | | | | | | | | | |
| Spokane (S-C-A) | [2]5,000 | [2]2,400 | C [2]2,500 | ..... | ..... | C [2]40 | ..... | S [2]500 | ..... |
| | ..... | ..... | R [2]1,100 | ..... | ..... | ..... | ..... | ..... | ..... |
| Union Oil Co. of Calif.: | | | | | | | | | |
| Edmonds (S) | [1]4,000 | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... |
| Total | 12,500 | 2,400 | 3,600 | ..... | ..... | * 40 | ..... | 3,100 | ..... |

(1) Vacuum operation used for primary distillation of crude oil, bbl. per calendar day. (2) Barrels per calendar day basis.

## WEST VIRGINIA

| Company, plant location and type | Crude oil | Vacuum dist. | Thermal operations | Cat. cr. | Cat. ref. | Poly. | Coke, tons per day | Asphalt | Lubes |
|---|---|---|---|---|---|---|---|---|---|
| Elk Ref. Co.: | | | | | | | | | |
| Falling Rock (S-C-L) | 4,500 | 1,500 | C 1,800 | ..... | Pf 1,500 | C 100 | ..... | ..... | 1,500 |
| Pure Oil Co., The: | | | | | | | | | |
| Cabin Creek (S-C-L) | 5,500 | ..... | [1]4,000 | ..... | ..... | C 110 | ..... | ..... | 450 |
| Quaker State O. R. Corp.: | | | | | | | | | |
| St. Marys (Comp.) | 2,500 | ..... | C 1,350 | ..... | ..... | ..... | ..... | ..... | 600 |
| Total | 12,500 | 1,500 | 7,150 | ..... | 1,500 | 210 | ..... | ..... | 2,550 |

(1) Total thermal operations including cracking, visbreaking and reforming.

## WISCONSIN

| Company, plant location and type | Crude oil | Vacuum dist. | Thermal operations | Cat. cr. | Cat. ref. | Poly. | Coke, tons per day | Asphalt | Lubes |
|---|---|---|---|---|---|---|---|---|---|
| Lake Superior Ref. Co.: | | | | | | | | | |
| Superior (S-C-A) | [1]6,000 | [2]2,000 | C 1,000 | ..... | Pf [2]1,000 | ..... | ..... | S [2]1,000 | ..... |
| | ..... | ..... | ..... | ..... | ..... | ..... | ..... | O [2]200 | ..... |
| Wisconsin O. R. Co., Inc.: | | | | | | | | | |
| Sheboygan (S-C) | 5,000 | ..... | ..... | Cy 1,000 | Cy 1,000 | ..... | ..... | ..... | ..... |
| Total | 11,000 | 2,000 | 1,000 | 1,000 | 2,000 | ..... | ..... | 1,200 | ..... |

(1) Includes 2,000 bbl. per day to be added in 1953. (2) To be placed in service during 1953.

## WYOMING

| Company, plant location and type— | Capacity ratings: Charging, bbl. per stream day: Crude oil | Vacuum dist. | Thermal operations | Cat. cr. | Cat. ref. | Production: Poly. | Coke, tons per day | Asphalt | Lubes |
|---|---|---|---|---|---|---|---|---|---|
| C & H Refinery: | | | | | | | | | |
| Lusk (S) | [1]160 | | | | | | | | |
| Continental Oil Co.: | | | | | | | | | |
| Glenrock (S-C) | 3,778 | | C 2,000 | | | C 100 | | | |
| Coop. Refinery Association: | | | | | | | | | |
| Newcastle (S-C) | 1,500 | | C 700 | | | | | | |
| Empire State Oil Co.: | | | | | | | | | |
| Thermopolis (S) | [3]5,000 | | | | | | | | |
| Frontier Ref. Co., The: | | | | | | | | | |
| Cheyenne (S-C-A) | 13,000 | 2,500 | C 3,875 | F 6,500 | | C 950 | | S 1,250 | |
| Husky Oil Co.: | | | | | | | | | |
| Cody (S-C) | [3]6,000 | [4]3,000 | | | At 1,000 | | | | |
| Ohio Oil Co., The: | | | | | | | | | |
| Lovell (S-A) | 6,000 | | | | | | | S 2,000 | |
| Pilot Oil Co.: | | | | | | | | | |
| Morton (S) | [1]200 | | | | | | | | |
| Resolute Oil Corp.: | | | | | | | | | |
| Badger Basin (S) | 1,000 | | | | | | | | |
| Sinclair Ref. Co.: | | | | | | | | | |
| Sinclair (S-C-A) | 25,000 | 9,000 | C 5,000 | F [2]12,000 | | C 350 | | S 750 | |
| | | | R 3,000 | | | | | | |
| Sioux Oil Co.: | | | | | | | | | |
| Newcastle (S) | [1]2,500 | | | | | | | | |
| Socony-Vacuum Oil Co., Inc.: | | | | | | | | | |
| Casper (S-C) | 7,000 | | | T 6,500 | | ([5]) | | [6]705 | |
| Standard Oil Co. (Ind.): | | | | | | | | | |
| Casper (Comp.) | 20,300 | 6,000 | C 4,450 | F 8,750 | | | 118 | S [1]1,000 | 650 |
| | | | Ck 2,500 | | | | | O [1]250 | |
| | | | | | | | | M 1,685 | |
| Texas Co., The: | | | | | | | | | |
| Casper (S-C-A) | 17,000 | | R 1,000 | F 6,000 | | C 500 | 100 | S [1]1,000 | |
| | | | Ck 3,000 | | | | | | |
| Total | 108,438 | 20,500 | 25,525 | 39,750 | 1,000 | 1,900 | 218 | 8,640 | 650 |

(1) Estimated. (2) Includes 3,000 bbl. per day to be added in 1953. (3) Includes 1,000 bbl. per day to be added in 1953. (4) New capacity for 1953 service. (5) Not reported. (6) Total asphalt production.

# Shutdown Plants in the United States

## CALIFORNIA

| Company and plant location— | Refinery type | Cap., bbl. per day: Crude oil | Cracking |
|---|---|---|---|
| Aromalene, Inc., Long Beach | S | 1,800 | |
| Bankline Oil Co., Maricopa | S | 5,000 | |
| Harbor Refg. Co., Long Beach | S | 3,000 | |
| Olympic Refg. Co., Long Beach | S | 5,500 | |
| Thornsbury Drlg. Co., Casmalia | S | 3,500 | |
| Westoil Terminals Co., San Pedro | S | 25,000 | |
| Total | | 42,000 | |

## IDAHO

| | | | |
|---|---|---|---|
| Phillips Pet. Co., Pocatello | S-C | 3,500 | 600 |

## ILLINOIS

| | | | |
|---|---|---|---|
| Ashland O&R Co., St. Elmo | S-C | 5,000 | 2,500 |
| Dupo Oil Refg. Co., Dupo | S | 1,000 | |
| Harmony Oil Corp., Salem | S-C | 4,000 | 2,000 |
| Sol-Tex Refg. Co., Fairfield | S | 2,500 | |
| Total | | 12,500 | 4,500 |

## KANSAS

| | | | |
|---|---|---|---|
| Chanute Ref. Co., Chanute | S-C | 1,500 | 1,000 |
| Bareco Oil Co., Wichita | S-C | 6,000 | 5,800 |
| Total | | 7,500 | 6,800 |

## LOUISIANA

| | | | |
|---|---|---|---|
| Coast Oil Co., Cotton Valley | S | 2,000 | |

## MICHIGAN

| | | | |
|---|---|---|---|
| Shamrock O&R Co., Saginaw | S | 3,500 | |

## MONTANA

| Company and plant location— | Refinery type | Cap., bbl. per day: Crude oil | Cracking |
|---|---|---|---|
| Hart Refineries, Missoula | S | 750 | |
| Hunt, Eugene, Winnett | S | 300 | |
| North Star Refg. Co., Shelby | S | 1,500 | |
| Solar O&R Co., Hardin | S | 1,500 | |
| Total | | 4,050 | |

## NEBRASKA

| | | | |
|---|---|---|---|
| Searle Pet. Co., Omaha | S | 2,000 | |

## OHIO

| | | | |
|---|---|---|---|
| Ashland O&R Co., Niles | S-C | 5,000 | 2,000 |

## OKLAHOMA

| | | | |
|---|---|---|---|
| Harper-Turner Oil Co., Edmond | S | 1,500 | |

## SOUTH DAKOTA

| | | | |
|---|---|---|---|
| Rex Oil Refg. Co., Rapid City | S | 200 | |
| How Kola Refg. Co., Sturgis | S | 130 | |

## TEXAS

| | | | |
|---|---|---|---|
| American Liberty Oil Co., Winnsboro | S-C | 3,000 | 1,800 |
| Consumers Coop. Ref. Assn., Levelland | S-C | 5,000 | 2,600 |
| LaSalle Pet. Corp., Burkburnett | S | 1,500 | |
| Total | | 9,500 | 4,400 |

## WYOMING

| | | | |
|---|---|---|---|
| Crook County Refy., Sundance | S | 125 | |
| Texas Co., The, Calpet | S | 500 | |
| Total | | 625 | |

## Summary of Refineries in Canada—Their Distribution and Capacity

| Province— | No. plants | Capacities, bbl. per stream day: Crude oil | Vacuum distillation | Thermal operations | Catalytic cracking | Catalytic reforming | Poly.* | Coke† | Asphalts* | Lubes* |
|---|---|---|---|---|---|---|---|---|---|---|
| Alberta | 10 | 61,000 | 12,600 | 24,150 | 14,600 | ..... | 625 | 100 | 3,445 | ..... |
| British Columbia | 3 | 52,850 | 9,100 | 6,625 | 7,600 | ..... | 50 | ..... | 4,715 | ..... |
| Manitoba | 4 | 20,200 | 4,370 | 7,075 | ..... | ..... | 50 | ..... | 260 | ..... |
| New Brunswick | 1 | 300 | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... |
| Northwest Territory | 1 | 1,250 | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... |
| Nova Scotia | 1 | 22,000 | ..... | 10,000 | ..... | ..... | ..... | ..... | 520 | ..... |
| Ontario | 5 | 103,500 | 16,000 | 39,700 | 32,850 | 4,000 | 1,400 | ..... | 4,150 | 5,000 |
| Quebec | 4 | 172,000 | 12,000 | 45,100 | 60,000 | ..... | 7,500 | ..... | 5,400 | ..... |
| Saskatchewan | 10 | 60,000 | 16,650 | 21,450 | 14,600 | ..... | 500 | 80 | 1,526 | ..... |
| Total | 39 | 493,100 | 70,720 | 154,100 | 129,650 | 4,000 | 10,125 | 180 | 20,016 | 5,000 |

*Production capacities, bbl. daily. †Production capacity, tons daily.

# Report on Canadian Operating Refineries

### ALBERTA

| Company, plant location and type— | Capacity ratings: Charging, bbl. per stream day: Crude oil | Vacuum dist. | Thermal operations | Cat. cr. | Cat. ref. | Production: Poly. | Coke, tons per day | Asphalt | Lubes |
|---|---|---|---|---|---|---|---|---|---|
| British American Oil Co.: | | | | | | | | | |
| Calgary (S-C-A) | 7,200 | 2,500 | C 2,500 | | | | | S 425 | |
| Edmonton (S-C) | 7,000 | ..... | C 1,400 | F 2,000 | ..... | ..... | 60 | ..... | ..... |
| | ..... | ..... | Ck 2,100 | ..... | ..... | ..... | ..... | ..... | ..... |
| Excelsior Refineries, Ltd.: | | | | | | | | | |
| Lloydminster (S-A) | 2,500 | 1,000 | ..... | ..... | ..... | ..... | ..... | S 1,000 | ..... |
| | ..... | ..... | ..... | ..... | ..... | ..... | ..... | O 500 | ..... |
| Gas & Oil Refineries, Ltd.: | | | | | | | | | |
| Hartell (S-C) | 3,000 | ..... | C 1,500 | ..... | ..... | C 75 | ..... | ..... | ..... |
| Imperial Oil, Ltd.: | | | | | | | | | |
| Calgary (S-C-A) | [1]9,200 | ..... | C [1]4,600 | ..... | ..... | T [1]300 | ..... | S [1]340 | ..... |
| | ..... | ..... | ..... | ..... | ..... | ..... | ..... | O [1]30 | ..... |
| Edmonton (S-C) | [1]22,600 | [1]8,500 | C [1]9,100 | F [1]10,000 | ..... | ..... | ..... | ..... | ..... |
| Bonnyville Oil Refineries: | | | | | | | | | |
| Bonneville (S) | 1,000 | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... |
| McColl-Frontenac Oil Co., Ltd.: | | | | | | | | | |
| Edmonton (S-C) | 5,500 | ..... | Ck 2,200 | F 2,600 | ..... | C 250 | 40 | ..... | ..... |
| Supreme Refineries, Ltd.: | | | | | | | | | |
| Ogden (S-C) | [2]1,500 | ..... | C [3]750 | ..... | ..... | ..... | ..... | S 250 | ..... |
| Wainwright Refineries, Ltd.: | | | | | | | | | |
| Wainwright (S-A) | [4]1,500 | [3]600 | ..... | ..... | ..... | ..... | ..... | S [5]900 | ..... |
| Total | 61,000 | 12,600 | 24,150 | 14,600 | ..... | 625 | 100 | 3,445 | ..... |

(1) Barrels per calendar day basis. (2) Includes 1,000 bbl. per day to be added in 1953. (3) New capacity to be placed in service during 1953. (4) Includes 900 bbl. per day to be added in 1953. (5) Includes 600 bbl. per day to be added in 1953.

### BRITISH COLUMBIA

| Company, plant location and type— | Crude oil | Vacuum dist. | Thermal operations | Cat. cr. | Cat. ref. | Poly. | Coke, tons per day | Asphalt | Lubes |
|---|---|---|---|---|---|---|---|---|---|
| Imperial Oil, Ltd.: | | | | | | | | | |
| Ioco (S-C-A) | [1]34,500 | [2]9,100 | C [2]2,750 | F [4]7,600 | ..... | ..... | ..... | S [3]320 | ..... |
| | ..... | ..... | ..... | ..... | ..... | ..... | ..... | O [3]195 | ..... |
| Shell Oil Co. of Canada, Ltd.: | | | | | | | | | |
| Shellburn (S-C-A) | 10,000 | ..... | C 3,400 | ..... | ..... | C 50 | ..... | [5]3,000 | ..... |
| | ..... | ..... | R 475 | ..... | ..... | ..... | ..... | ..... | ..... |
| Standard Oil Co. of B. C., Ltd.: | | | | | | | | | |
| Burnaby (S-A) | [6]8,350 | ..... | ..... | ..... | ..... | ..... | ..... | S 1,200 | ..... |
| Total | 52,850 | 9,100 | 6,625 | 7,600 | ..... | 50 | ..... | 4,715 | ..... |

(1) Barrels per calendar day and includes 22,500 bbl. per day to be added in 1953. (2) Barrels per calendar day, to be added in 1953. (3) Barrels per calendar day. (4) Barrels per calendar day, to be added in 1953. (5) Flux and asphalt. (6) Capacity falls to 5,000 bbl. daily when running for asphalt in which operation one of plant's two distillation units is on vacuum.

### MANITOBA

| Company, plant location and type— | Crude oil | Vacuum dist. | Thermal operations | Cat. cr. | Cat. ref. | Poly. | Coke, tons per day | Asphalt | Lubes |
|---|---|---|---|---|---|---|---|---|---|
| Anglo-Canadian Oils, Ltd.: | | | | | | | | | |
| Brandon (S-C) | 3,000 | ..... | C 1,375 | ..... | ..... | C 50 | ..... | ..... | ..... |
| Imperial Oil, Ltd.: | | | | | | | | | |
| Winnipeg (S-C-A) | [1]12,000 | [1]4,370 | F [1]3,600 | ..... | ..... | ..... | ..... | S [1]260 | ..... |
| North Star Oil, Ltd.: | | | | | | | | | |
| St. Boniface (S-C) | 4,200 | ..... | C 1,000 | ..... | ..... | ..... | ..... | ..... | ..... |
| | ..... | ..... | R 1,100 | ..... | ..... | ..... | ..... | ..... | ..... |
| Radio Oil Refineries, Ltd.: | | | | | | | | | |
| E. Kildonan (S) | 1,000 | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... |
| Total | 20,200 | 4,370 | 7,075 | ..... | ..... | 50 | ..... | 260 | ..... |

(1) Barrels per calendar day.

## NEW BRUNSWICK

| Company, plant location and type— | Capacity ratings: Charging, bbl. per stream day: Crude oil | Vacuum dist. | Thermal operations | Cat. cr. | Cat. ref. | Production: Poly. | Coke, tons ped day | Asphalt | Lubes |
|---|---|---|---|---|---|---|---|---|---|
| N. B. Oilfields, Ltd.: | | | | | | | | | |
| Weldon (S) | 300 | | | | | | | | |

## NORTHWEST TERRITORY

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Imperial Oil, Ltd.: | | | | | | | | | |
| Norman Wells (S) | [1]1,250 | | | | | | | | |

(1) Barrels per calendar day.

## NOVA SCOTIA

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Imperial Oil, Ltd.: | | | | | | | | | |
| Halifax (S-C-A) | [1]22,000 | | C [1]10,000 | | | | | S [1]520 | |
| | | | | | | | | O [1]175 | |

(1) Barrels per calendar day.

## ONTARIO

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| British American Oil Co., Ltd., The: | | | | | | | | | |
| Clarkson (Comp.) | 17,000 | 6,000 | C 4,500 | | | | | S 1,300 | 1,200 |
| | | | | | | | | O 870 | |
| Canadian Oil Cos., Ltd.: | | | | | | | | | |
| Sarnia (S-C) | 20,000 | 10,000 | V 4,000 | F 9,000 | Pf 4,000 | C 1,400 | | | |
| Imperial Oil, Ltd.: | | | | | | | | | |
| Sarnia (Comp.) | [1]57,000 | | V [2]4,000 | F [3]23,250 | | | | S [2]910 | 3,800 |
| | | | C [2]23,000 | | | | | O [2]1,070 | |
| Riverlake Oils, Ltd.: | | | | | | | | | |
| Fort William (S-C) | 2,500 | | | Cy 600 | | | | | |
| Trinidad Leaseholds (Canada), Ltd.: | | | | | | | | | |
| Port Credit (S-C) | 7,000 | | C 3,600 | | | | | | |
| | | | R 600 | | | | | | |
| Total | 103,500 | 16,000 | 39,700 | 32,850 | 4,000 | 1,400 | | 4,150 | 5,000 |

(1) Barrels per calendar day and excludes new capacity under construction. (2) Barrels per calendar day. (3) Barrels per calendar day to be added in 1953.

## QUEBEC

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| British American Oil Co., Ltd., The: | | | | | | | | | |
| Montreal (S-C-A) | 45,000 | 12,000 | C 3,500 | F 17,500 | | C 500 | | S 1,600 | |
| | | | | | | | | O 1,300 | |
| | | | | | | | | M 400 | |
| Imperial Oil, Ltd.: | | | | | | | | | |
| Montreal East (S-C-A) | [1]46,000 | | V [1]10,500 | F [1]15,500 | | T [1]4,400 | | S [1]1,690 | |
| | | | R [1]3,800 | | | | | O [1]410 | |
| McColl-Frontenac Oil Co., Ltd.: | | | | | | | | | |
| Montreal East (S-C) | 43,000 | | C 4,200 | F 14,500 | | C 1,500 | | | |
| | | | V 9,600 | | | | | | |
| | | | R 4,500 | | | | | | |
| Shell Oil Co. of Canada, Ltd.: | | | | | | | | | |
| Montreal East (S-C) | [2]38,000 | | [3]9,000 | F 12,500 | | C 1,100 | | | |
| Total | 172,000 | 12,000 | 45,100 | 60,000 | | 7,500 | | 5,400 | |

(1) Barrels per calendar day. (2) Includes 5,000 bbl. per day to be added in 1953. (3) Total thermal operations.

## SASKATCHEWAN

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| British American Oil Co., Ltd., The: | | | | | | | | | |
| Moose Jaw (S-C) | 15,000 | 7,500 | C 1,500 | F 4,500 | | C 500 | 80 | S 500 | |
| | | | Ck 2,500 | | | | | | |
| Consumers Coop. Refs., Ltd.: | | | | | | | | | |
| Regina (S-C) | 7,000 | | C 2,450 | | | | | | |
| Hi-Way Refineries, Ltd.: | | | | | | | | | |
| Moose Jaw (S) | 350 | | | | | | | | |
| Rosetown (S) | 350 | | | | | | | | |
| Saskatoon (S-C) | [1]6,500 | | C 1,500 | F [2]2,600 | | | | | |
| | | | V [3]3,500 | | | | | | |
| Husky Oil & Ref., Ltd.: | | | | | | | | | |
| Lloydminster (S) | [3]10,000 | | | | | | | | |
| Imperial Oil, Ltd.: | | | | | | | | | |
| Regina (S-C-A) | [4]17,000 | [2]9,150 | C [4]9,700 | F [2]7,500 | | | | S [4]310 | |
| | | | | | | | | O [4]16 | |
| Moose Jaw Refineries, Ltd.: | | | | | | | | | |
| Moose Jaw (S-C-A) | 2,000 | | R 300 | | | | | S 700 | |
| Northern Pet. Corp., Ltd.: | | | | | | | | | |
| Kamsack (S) | 800 | | | | | | | | |
| Prince Albert Refineries, Ltd.: | | | | | | | | | |
| Prince Albert (S) | 1,000 | | | | | | | | |
| Total | 60,000 | 16,650 | 21,450 | 14,600 | | 500 | 80 | 1,526 | |

(1) Includes 1,500 bbl. per day to be added in 1953. (2) New capacity to go into service in 1953. (3) Capacity when operating for bunker fuel. (4) Barrels per calendar day.

NOTE: See page 336 for list of Shutdown Plants in Canada and Summary of Refineries in Mexico.

# New Facilities to Add 150,000 Bbl. Daily

**Three new refinery projects are now under way in the United States, two of which are scheduled to go into operation during this year**

NEW facilities are being added to a large number of United States and Canadian refineries. In the first quarter of this year expansion of crude units, involving around 150,000 bbl. per day of capacity, was under way in 25 different United States refineries. This capacity is scheduled to go into service during 1953. In addition to these projects there are four being started which will increase 1954 crude-oil capacity by nearly 20,000 bbl. daily.

Currently five new crude units are slated to go on stream this year. These projects, now building, involve 240,000 bbl. per day of capacity. Just getting under way are six more new crude units which are schedu'ed for completion for next year. Capacity rating on this group is about 150,000 bbl. daily.

New cat cracking units and associated facilities now building will give an appreciab'e boost to the nation's capacity during this year. Currently there are 30 projects involving 375,000 bbl. per year of new capacity which is to go on stream in 1953.

Schedules for 1954 call for additional catalytic cracking capacity of upwards of 95,000 bbl. per day. Many of the projects which will provide this new capacity are just getting under way for completion late in 1954. Like the projects scheduled for service this year, many of next year's new catalytic units involve feed-preparation facilities, gas-concentration plants, and in a number of instances, polymerization plants.

Projects involving new catalytic reformers for 1953 operation add around 120,000 bbl. per day of capacity. This capacity is made up of nearly 20 projects. For next year the seven projects now starting will add about 90,000 bbl. daily.

As of the first quarter of this year, three new refinery projects are under way in the United States. Two of these new plants are set for operation in 1953. The other is scheduled to go on stream in 1954. Currently, construction of two new refineries has been authorized; both projects include cat cracking and associated facilities. Combined crude-oil capacity of these new refineries is 45,000 bbl. daily.

New refinery projects not yet finally authorized add up to six. Three and possibly four of these new refinery projects may be set in motion before this year's end. The other two projects are still in the planning stage. However, one of the projects may receive authorization soon.

Two of the six new refinery projects which have not yet been finally authorized have passed preliminary design stages. Progress on a third project is well advanced into final design.

Expansion of Canada's refining capacity is approximately proportional to that of the United States. Plans for new refining facilities in various sections of Canada include new plants and extensive expansion of existing refineries.

The over-all picture, as of the first quarter of this year, indicates that United States crude-oil charging capacity, on a stream-day basis, will soar to 8.3 million barrels by the end of 1954. Cat cracking will be upped about 100,000 bbl. daily for the same period and cat reforming 65,000 bbl.

## Active Refinery-Building Projects

| Company, location, type of project and contractor— | Capacity rating | Completion schedule |
|---|---|---|
| Aerex Co., Bloomfield, N. M.: | | |
| *Plant enlargement, bbl. per day | 750 | Early '53 |
| Allied Chem. & Dye Corp., Orange, Tex.: | | |
| *Petrochem plant | | 1954 |
| American Liberty Oil Co., Mt. Pleasant, Tex.: | | |
| *Vacuum unit, bbl. per day | 1,800 | 1953 |
| *Visbreaker, bbl. per day | 3,000 | 1953 |
| *Cat cracker, bbl. per day | 5,000 | 1953 |
| Ashland O. & R. Co., Ashland, Ky.: | | |
| *Revamp crude unit, bbl. per day | 5,000 | 1953 |
| *Vacuum unit, bbl. per day | 10,000 | 1953 |
| *Cat cracker, bbl. per day | 10,000 | 1953 |
| †Visbreaker, bbl. per day | 1,800 | 1953 |
| Ashland O. & R. Co., Findlay, Ohio: | | |
| †Crude unit, bbl. per day | 6,000 | 1953 |
| *Vacuum unit, bbl. per day | 8,000 | 1953 |
| *Asphalt facilities | | 1953 |
| Atlantic Ref. Co., Philadelphia: E. B. Badger & Sons Co. | | |
| *Cat reformer, bbl. per day | 10,000 | 1953 |
| *Crude unit, bbl. per day | 45,000 | 1954 |
| *Cat cracker, bbl. per day | 30,000 | 1954 |
| *Alkylation unit, bbl. per day | 3,000 | Late '53 |
| *Ammonia plant, tons per day | 100 | Mid '53 |
| Aurora Gasoline Co., Detroit: | | |
| *Increase cat reformer, bbl. per day | 1,500 | 1953 |
| Aurora Gasoline Co., Elsie, Mich.: | | |
| *Cat reformer, bbl. per day | 1,500 | 1953 |
| Bay Petroleum Corp., Denver: Universal Oil Products Co. and Procon, Inc. | | |
| *Cat cracker, bbl. per day | 3,500 | Mid '53 |
| *Feed prep. unit, bbl. per day | 2,340 | Mid '53 |
| *Revamp poly unit, bbl. per day | 220 | Mid '53 |
| *Gas concentration unit, bbl. per day | | Mid '53 |
| Bell O. & G. Co., Grandfield, Okla.: | | |
| †Expand crude unit, bbl. per day | 1,000 | Early '54 |
| *Enlarge cat reformer, bbl. per day | 400 | Late '53 |
| Ben Franklin Ref. Co., Ardmore, Okla.: | | |
| *Increase crude oil cap., bbl. per day | 2,000 | 1953 |
| *Vacuum unit, bbl. per day | 7,000 | 1953 |
| *Coking unit, bbl. per day | 5,000 | 1953 |
| *Cat cracker, bbl. per day | 6,000 | 1953 |
| *Increase thermal poly unit, bbl. per day | 500 | 1953 |
| *Asphalt facilities, bbl. per day | 1,100 | 1953 |
| British American Oil Co., Ltd., Clarkson, Ont.: | | |
| *Cat cracker, bbl. per day | 11,000 | 1954 |
| *Cat poly unit, bbl. per day | 600 | 1954 |
| *Grease plant, tons per year | 7,500 | 1953 |
| Calstate Ref. Co., Long Beach, Calif.: | | |
| *Revamp thermal cracker bbl. per day | 500 | 1953 |
| Calumet Ref. Co., Princeton, La.: | | |
| *Lube vac. unit increase, bbl. per day | 250 | Mid '53 |
| Carbide & Carbon Chem. Div., Torrance, Calif.: | | |
| *Petrochem plant | | |
| Carter Oil Co., Billings, Mont.: Blaw-Knox Construction Co. | | |
| *Poly plant, bbl. per day | 600 | 1953 |
| Champlin Ref. Co., Enid, Okla.: | | |
| ‡Cat reformer | | |
| Cities Service Oil Co. (Del.), E. Chicago, Ind.: | | |
| *New crude unit, bbl. per day | 12,000 | Early '54 |
| *Increase coker, tons per day | 380 | Early '54 |
| *New cat reformer, bbl. per day | 12,500 | Early '54 |
| Cities Service Oil Co. (Del.), Linden, N. J.: | | |
| ‡Vacuum unit, bbl. per day | 5,600 | |
| Cities Service Ref. Corp., Lake Charles, La: | | |
| *Distillation facilities, bbl. per day | 25,000 | 1953 |
| *Cat reformer, bbl. per day | 15,000 | 1953 |

*Building. †Authorized. ‡Planned. §Contracted.

| Company, location, type of project and contractor— | Capacity rating | Completion schedule |
|---|---|---|
| Col-Tex Ref. Co., Colorado City, Tex.: | | |
| *Cat reformer, bbl. per day | 1,500 | 1953 |
| Consumers Coop. Refs., Ltd., Regina, Sask.: | | |
| *Crude unit, bbl. per day | 8,000 | Mid '54 |
| *Vacuum unit, bbl. per day | 6,500 | Mid '54 |
| *Cat cracker, bbl. per day | 4,500 | Mid '54 |
| *Poly unit, bbl. per day | 500 | Mid '54 |
| Continental Oil Co., Ponca City, Okla.: | | |
| *Revise Alky unit, bbl. per day | 1,750 | 1953 |
| Continental Oil Co., Lake Charles, La.: Stone & Webster Engr. Corp., Badger Process Corp., Universal Oil Products Co. and Procon, Inc. | | |
| *Refinery expansion, bbl. per day | 40,000 | 1953 |
| *Cat reformer, bbl. per day | 6,000 | 1953 |
| *Cat cracker, bbl. per day | 17,000 | 1953 |
| Coop. Ref. Assn., Phillipsburg, Kans.: | | |
| *Crude unit increase, bbl. per day | 4,500 | Early '53 |
| *Vacuum unit, bbl. per day | 3,500 | Early '53 |
| *Cat poly unit, bbl. per day | 300 | Early '53 |
| *Cat cracker, bbl. per day | 4,500 | Early '53 |
| *Gas concentration plant | | Early '53 |
| Crystal Ref. Co. of Carson City, Inc., Carson City, Mich.: | | |
| *TEL blending plant | | Early '53 |
| Danaho Ref. Co., Pettus, Tex.: | | |
| †Cat cracker, bbl. per day | 3,500 | 1954 |
| †Cat poly unit, bbl. per day | 250 | 1954 |
| Delta Refining Co., Memphis, Tenn.: Koch Engineering Co. | | |
| *Cat cracker, bbl. per day | 2,700 | 1953 |
| *Cat poly plant | | |
| *Crude cap. increase, bbl. per day | 2,000 | 1953 |
| Dewese Oil Refinery, Weston, Ohio: | | |
| ‡Cat cracker | | |
| Diamond Alkali Co., Deer Park, Tex.: | | |
| *Petrochemical plant | | |
| Dow Chemical Co., Midland, Mich.: Stone & Webster Engineering Corp. | | |
| *Toluene plant | | |
| Dow Chemical Co., Sarnia, Ont.: | | |
| *Petrochemical plant | | |
| Eastern States Pet. Co., Inc., Houston: | | |
| †Alkylation plant, bbl. per day | 2,225 | |
| Empire Pet. Co., Denver, Colo.: | | |
| *Crude unit expansion, bbl. per day | 5,000 | 1953 |
| Envoy Pet. Co., Long Beach, Calif.: | | |
| †Asphalt facilities, bbl. per day | 700 | |
| Esso Standard Oil Co., Everett, Mass.: Foster Wheeler Corp. | | |
| *Crude unit increase, bbl. per day | 18,000 | 1953 |
| *Vacuum unit, bbl. per day | 13,100 | 1953 |
| *Cat cracker, bbl. per day | 24,000 | 1953 |
| *Reformer cap. increase, bbl. per day | 1,150 | 1953 |
| *Poly plant cap. increase, bbl. per day | 400 | 1953 |
| Esso Standard Oil Co., Baton Rouge: M. W. Kellogg Co. | | |
| *Crude cap. increase, bbl. per day | 46,700 | 1953 |
| *Low press. cracker, bbl. per day | 6,200 | 1953 |
| Esso Standard Oil Co., Linden, N. J.: | | |
| *Crude cap. increase, bbl. per day | 27,000 | 1954 |
| Famriss O. & R. Co., Monument, N. M.: | | |
| ‡Crude cap. increase, bbl. per day | 2,000 | Late '53 |
| ‡Cat reformer, bbl. per day | 750 | Late '53 |
| Frontier O. & R. Corp., Tonawanda, N. Y.: | | |
| *Crude cap. increase, bbl. per day | 5,000 | 1953 |
| *Vacuum unit, bbl. per day | 10,000 | 1953 |
| *Cat cracker, bbl. per day | 10,000 | 1953 |
| *Visbreaker, bbl. per day | 1,800 | 1953 |
| Fulton & Olmstead, San Antonio: Koch Engr. Co. and Universal Oil Products Co. | | |
| †New refinery | | 1954 |
| Crude unit, bbl. per day | 10,000 | |
| Cat cracker, bbl. per day | 4,650 | |
| Cat reformer, bbl. per day | 1,640 | |
| General Pet. Corp., Torrance, Calif.: Bechtel Corp.: | | |
| *Cat reformer, bbl. per day | 19,000 | Mid '54 |
| General Pet. Corp., Ferndale, Wash.: | | |
| †New refinery, bbl. per day | 35,000 | |
| Gilmore Refineries, Inc., Odessa, Tex.: | | |
| ‡New refinery, bbl. per day | 50,000 | |
| Great Northern Oil Co., North Dakota: | | |
| ‡New refinery, bbl. per day | 30,000 | |
| Great Southern Corp., Corpus Christi, Tex.: | | |
| Cat reformer, bbl. per day | 3,500 | Mid '53 |
| Gulf Oil Corp., Philadelphia: M. W. Kellogg | | |
| *Cat cracker, bbl. per day | 60,000 | Mid '53 |
| *Cat reformer, bbl. per day | 30,000 | Mid '53 |
| *Cat poly unit, bbl. per day | 3,600 | Mid '53 |
| *Crude cap. increase, bbl. per day | 76,000 | Mid '53 |
| Hi-Way Refs., Ltd., Saskatoon, Sask.: | | |
| *Crude cap. increase, bbl. per day | 1,500 | 1953 |
| *Visbreaker, bbl. per day | 3,500 | 1953 |
| *Cat cracker, bbl. per day | 2,600 | 1953 |
| *Gas concentration plant | | 1953 |
| Husky Oil Co., Cody, Wyo.: Koch Engr. Co. and Grebe & Doremus | | |
| *Cat reformer, bbl. per day | 1,000 | Mid '53 |
| *Vacuum unit, bbl. per day | 3,000 | Mid '53 |
| *Cat reformer, bbl. per day | 1,000 | Mid '53 |
| Imperial Oil, Ltd., Ioco, B. C.: | | |
| *Crude cap. increase, bbl. per day | 22,500 | Late '53 |
| *Vacuum unit, bbl. per day | 9,100 | Late '53 |
| *Cat cracker, bbl. per day | 7,600 | Late '53 |
| Imperial Oil, Ltd., Regina, Sask.: | | |
| *Cat cracker, bbl. per day | 7,500 | Early '54 |
| *Vacuum unit, bbl. per day | 9,150 | Early '54 |
| Imperial Oil, Ltd., Sarnia, Ont.: | | |
| *Atmos.-vac. unit, bbl. per day | 46,500 | Early '53 |
| *Cat cracker, bbl. per day | 23,250 | Early '53 |
| Ingram Products Co., Meraux, La.: Koch Engr. Co. and Universal Products Co. | | |
| *Cat cracker, bbl. per day | 3,000 | 1953 |
| *Crude cap. increase, bbl. per day | 1,000 | 1953 |
| *Cat poly plant | | |
| *Gas concentration unit | | |
| International Refs., Inc., Wrenshal, Minn.: Lummus Co. | | |
| *New refinery, bbl. per day | 11,500 | Late '53 |
| Kamloops Refy. Syndicate, Kamloops, B. C.: | | |
| ‡New refinery, bbl. per day | 2,500 | 1954 |
| Kerr-McGee Oil Industries, Inc., Wynnewood, Okla.: | | |
| *Crude cap. increase, bbl. per day | 2,000 | 1953 |
| *Vacuum unit increase, bbl. per day | 1,000 | 1953 |
| Lakeside Refining Co., Kalamazoo, Mich.: | | |
| *Cracker-visbreaker, bbl. per day | 1,600 | Mid '53 |
| Lake Superior Ref. Co., Superior, Wis.: | | |
| *Cat reformer, bbl. per day | 1,000 | Mid '53 |
| *Vacuum unit, bbl. per day | 2,000 | Mid '53 |
| *Asphalt facilities, bbl. per day | 1,200 | Mid '53 |
| Lion Oil Co., El Dorado, Ark.: | | |
| *Cat cracker, bbl. per day | 10,000 | 1953 |
| *Alkylation unit, bbl. per day | 1,000 | 1953 |
| *Vapor recovery unit | | 1953 |
| McMurrey Refining Co., Tyler, Tex.: | | |
| *Cat reformer, bbl. per day | 5,000 | Mid '53 |
| *Contact coker, bbl. per day | 1,500 | Mid '53 |
| Malco Refineries, Inc., Prewitt, N. M.: Grebe & Doremus Process Co. | | |
| *Cat reformer | | 1953 |
| *Crude unit increase, bbl. per day | 3,500 | 1953 |
| Mercury Oil Ref. Co., Oklahoma City: | | |
| †Crude unit increase, bbl. per day | 7,000 | Early '54 |
| †Cat cracker, bbl. per day | 2,500 | Early '54 |
| †Poly unit | | Early '54 |
| Mid-Continent Pet. Corp., Tulsa: | | |
| *Cat cracker increase, bbl. per day | 6,500 | Mid '53 |
| *New debutanizer, bbl. per day | 10,000 | Mid '53 |
| *Alkylation unit increase, bbl. per day | 1,800 | Mid '53 |
| Midland Coop. Wholesale, Cushing, Okla.: Refinery Engr. Co. and Universal Oil Products Co. | | |
| *Cat cracker, bbl. per day | 4,500 | Mid '53 |
| *Cat poly plant, bbl. per day | 400 | Mid '53 |
| *Crude cap. increase, bbl. per day | 4,500 | Mid '53 |
| *Vac.-visbreaker unit, bbl. per day | 5,000 | Mid '53 |
| *Gas concentration unit | | Mid '53 |

*Building. †Authorized. ‡Planned. §Contracted.

| Company, location, type of project and contractor— | Capacity rating | Completion schedule |
|---|---|---|
| Mid-West Refs., Inc., Alma, Mich.: | | |
| *Thermal cracker increase, bbl. per day | 1,200 | 1953 |
| Monsanto Chemical Co., Avon, Calif.: | | |
| *Petrochem plant | ..... | Late '54 |
| National Coop. Refinery Assn., McPherson, Kans.: | | |
| Refinery Engr. Co. and Universal Oil Products Co. | | |
| *Coking unit, bbl. per day | 10,000 | Early '53 |
| New Mexico Asphalt & Refining Co., Artesia, N. M.: | | |
| *New asphalt facilities, bbl. per day | 1,500 | 1953 |
| North Star Oil, Ltd., St. Boniface, Man.: | | |
| ‡Crude capacity increase | ..... | .... |
| ‡Vacuum unit | ..... | .... |
| ‡Cat cracker | ..... | .... |
| ‡Poly plant | ..... | .... |
| ‡Gas concentration unit | ..... | .... |
| Northwestern Ref. Co., St. Paul Park, Minn.: | | |
| Universal Oil Products Co. and Procon, Inc. | | |
| *Cat cracker, bbl. per day | 5,000 | Early '53 |
| *New crude unit, bbl. per day | 30,000 | 1953 |
| *Vacuum unit, bbl. per day | 10,000 | 1953 |
| *Asphalt facilities increase, bbl. per day | 5,000 | 1953 |
| Ohio Oil Co., Robinson, Ill.: | | |
| Lummus Co. | | |
| *Coking unit, bbl. per day | 6,000 | 1953 |
| Catalytic Construction Co. | | |
| *Cat reformer, bbl. per day | 8,000 | 1953 |
| *Cat cracker increase, bbl. per day | 3,500 | 1953 |
| Pacific O. & R. Co., Seattle: | | |
| ‡New refinery, bbl. per day | 10,000 | .... |
| Pan American Ref. Corp., Texas City, Tex.: | | |
| Lummus Co. | | |
| *Cat cracker, bbl. per day | 30,000 | 1953 |
| *Cat poly, bbl. per day | 2,400 | 1953 |
| *Crude cap. increase, bbl. per day | 3,000 | 1953 |
| *Alkylation unit increase, bbl. per day | 2,400 | 1953 |
| Pan American Southern Corp., El Dorado, Ark.: | | |
| ‡Cat reforming facilities | ..... | .... |
| Pan American Southern Corp., Destrehan, La.: | | |
| *Coking unit, bbl. per day | 9,300 | Early '53 |
| Pana Refining Co., Pana, Ill.: | | |
| *Crude unit increase, bbl. per day | 1,500 | 1953 |
| *Cat reformer, bbl. per day | 650 | 1953 |
| Paragon Oil Co., Newark, N. J.: | | |
| ‡New refinery: | | |
| Crude unit, bbl. per day | 20,000 | .... |
| Cat cracker, bbl. per day | 9,000 | .... |
| Cat reformer, bbl. per day | 4,000 | .... |
| Pet. Specialties, Inc., Flat Rock, Mich.: | | |
| *Visbreaker, bbl. per day | 2,500 | 1953 |
| Petco Corp., Marrero, La.: | | |
| *Crude cap. increase, bbl. per day | 5,000 | Mid '53 |
| *Cat cracker, bbl. per day | 1,000 | 1953 |
| Premier Pet. Co., Fort Worth: | | |
| ‡Cat cracker | ..... | .... |
| ‡Cat poly unit | ..... | .... |
| ‡Gas concentration plant | ..... | .... |
| Premier Pet. Co., Longview, Tex.: | | |
| *Cat poly unit, bbl. per day | 90 | 1953 |
| Proven O. & R. Co., Florence, Ariz.: | | |
| ‡New refinery: | | |
| Crude unit, bbl. per day | 16,500 | .... |
| Cat cracker, bbl. per day | 8,000 | .... |
| Alkylation unit, bbl. per day | 700 | .... |
| Pure Oil Co., Nederland, Tex.: | | |
| M. W. Kellogg Co. | | |
| *Crude cap. increase, bbl. per day | 12,000 | Early '53 |
| *Alkylation unit increase, bbl. per day | 925 | Early '53 |
| *Cat cracker, bbl. per day | 17,750 | Early '53 |
| *Cat poly unit, bbl. per day | 825 | Early '53 |
| Pure Oil Co., Toledo: | | |
| Catalytic Construction Co. | | |
| *Naphtha treater | ..... | Mid '53 |
| *Cat cracker, bbl. per day | 11,600 | Mid '53 |
| *Cat poly, bbl. per day | 1,270 | Mid '53 |

| Company, location, type of project and contractor— | Capacity rating | Completion schedule |
|---|---|---|
| Rado Refining Co., McAllen, Tex.: | | |
| Crude cap. increase, bbl. per day | 800 | Late '53 |
| Republic O. R. Co., Texas City, Tex.: | | |
| Universal Oil Products Co. | | |
| *Cat reformer, bbl. per day | 5,500 | Mid '53 |
| Richfield Oil Corp., Watson, Calif.: | | |
| Fluor Corp., Ltd., and C. F. Braun Co. | | |
| *Cat cracker, bbl. per day | 35,000 | 1954 |
| *Cat poly unit, bbl. per day | 2,000 | 1954 |
| *Alkylation plant increase, bbl. per day | 3,000 | 1954 |
| *Vacuum unit, bbl. per day | 60,000 | 1954 |
| *Crude unit, bbl. per day | 15,000 | 1954 |
| Salt Lake Ref. Co., Salt Lake City: | | |
| *Gas oil treater, bbl. per day | 1,000 | 1953 |
| Shallow Water Refining Co., Garden City, Kans.: | | |
| ‡Cat cracker, bbl. per day | 3,000 | .... |
| ‡Cat poly increase, bbl. per day | 150 | .... |
| Shell Chemical Co., Ventura, Calif.: | | |
| *Petrochem plant, tons per day | 150 | Mid '53 |
| Shell Oil Co., Houston: | | |
| Universal Oil Products Co. | | |
| *Cat reformer, bbl. per day | 12,000 | Early '53 |
| Shell Oil Co., Norco, La.: | | |
| *Crude cap. increase, bbl. per day | 25,000 | Mid '54 |
| *Cat cracker, bbl. per day | 48,000 | Mid '54 |
| Shell Oil Co., Puget Sound, Wash.: | | |
| ‡New refinery, bbl. per day | 50,000 | .... |
| Shell Oil Co., Wilmington, Calif.: | | |
| ‡Crude cap. increase, bbl. per day | 14,000 | 1954 |
| Shell Oil Co., Wood River, Ill.: | | |
| Universal Oil Products Co. and Procon, Inc. | | |
| *Cat reformer, bbl. per day | 16,000 | 1954 |
| *Alkylation unit increase | .... | 1954 |
| *Crude cap. increase, bbl. per day | 35,000 | Mid '53 |
| Shell Oil Co. of Canada, Ltd., Montreal: | | |
| C. F. Braun Co. | | |
| *Acetone-alcohol plant, tons per year | 10,000 | Early '53 |
| Shell Oil Co. of Canada, Ltd., Vancouver: | | |
| *Crude cap. increase, bbl. per day | 7,000 | Late '53 |
| *Cat cracker, bbl. per day | 5,000 | Late '53 |
| Sinclair Refining Co., Houston: | | |
| C. F. Braun Co. and Fluor Corp., Ltd. | | |
| *Cat cracker, bbl. per day | 40,000 | Late '53 |
| *Crude unit, bbl. per day | 35,000 | Late '53 |
| *Vacuum-flash unit, bbl. per day | 20,000 | Late '53 |
| *Vacuum still, bbl. per day | 15,000 | Late '53 |
| Sinclair Refining Co., Sinclair, Wyo.: | | |
| *Cat cracker increase, bbl. per day | 3,000 | 1953 |
| Sinclair Refining Co., Hartford, Ill.: | | |
| *$SO_2$ treater, bbl. per day | 10,000 | 1953 |
| Socony-Vacuum Oil Co. Inc., Augusta, Kans.: | | |
| *Cat reformer, bbl. per day | 3,000 | Mid '54 |
| Socony-Vacuum Oil Co., Inc., E. St. Louis, Ill.: | | |
| §Cat cracker, bbl. per day | 15,000 | Early '54 |
| Socony-Vacuum Oil Co., Inc., Paulsboro, N. J.: | | |
| *Cat cracker, bbl. per day | 18,000 | Early '53 |
| Socony-Vacuum Oil Co., Inc., Trenton, Mich.: | | |
| *Cat poly | ..... | Late '53 |
| Standard Oil Co. of Calif., El Segundo, Calif.: | | |
| *Cat cracker, bbl. per day | 36,000 | 1954 |
| *Vacuum flasher, bbl. per day | 54,000 | 1954 |
| Standard Oil Co. (Ind.), Casper, Wyo.: | | |
| M. W. Kellogg Co. | | |
| §Alkylation unit, bbl. per day | 700 | 1954 |
| Standard Oil Co. (Ind.), Neodesha, Kans.: | | |
| *Cat cracker, bbl. per day | 9,000 | 1953 |
| *Alkylation unit, bbl. per day | 1,000 | 1953 |
| Standard Oil Co. (Ind.), Sugar Creek, Mo.: | | |
| *Coking unit, bbl. per day | 33,000 | 1953 |
| Standard Oil Co. (Ind.), Mandan, N. D.: | | |
| *New refinery, bbl. per day | 33,000 | 1954 |
| Standard Oil Co. (Ind.), Whiting, Ind.: | | |
| *Motor-oil facilities increase, bbl. per day | 540 | 1953 |
| Standard Oil Co. (Ind.), Wood River, Ill.: | | |
| *Cat reformer, bbl. per day | 9,000 | 1954 |

*Building. †Authorized. ‡Planned. §Contracted.

| Company, location, type of project and contractor— | Capacity rating | Completion schedule |
|---|---|---|
| Standard Oil Co. (Ohio), Cleveland: | | |
| *Cat cracker increase, bbl. per day | 3,000 | 1954 |
| Standard Oil Co. (Ohio), Lima, Ohio: | | |
| *Cat cracker increase, bbl. per day | 3,000 | 1954 |
| *Cat reformer, bbl. per day | 12,000 | Early '54 |
| Standard Oil Co. (Ohio), Toledo: | | |
| *Alkylation unit increase, bbl. per day | 2,000 | 1953 |
| Sun Oil Co., Toledo: | | |
| *Cat reformer, bbl. per day | 15,000 | 1953 |
| Sun Oil Co., Sarnia, Ont.: | | |
| *New refinery, bbl. per day | 15,000 | Late '53 |
| Suntide Refining Co., Corpus Christi, Tex.: | | |
| Lummus Co. | | |
| *New refinery | | Late '53 |
| Crude unit, bbl. per day | 30,000 | |
| Vacuum unit, bbl. per day | 10,000 | |
| Cat cracker, bbl. per day | 15,000 | |
| Cat poly, bbl. per day | 2,000 | |
| Sunset Oil Co., Torrance, Calif.: | | |
| *Thermal cracker, bbl. per day | 2,500 | Mid '53 |
| *Thermal poly plant, bbl. per day | 400 | Mid '53 |
| Supreme Refs., Ltd., Ogden, Alta.: | | |
| ‡Cat cracker | | |
| Taylor O. & G. Co., Corpus Christi, Tex.: | | |
| *Cat reformer, bbl. per day | 5,000 | Mid '53 |
| Texas City Refg. Co., Texas City, Tex.: | | |
| *Cat cracker, bbl. per day | 17,500 | Mid '53 |
| *Vac-flash-visbr., bbl. per day | 3,750 | Mid '53 |
| Texas Co., Amarillo, Tex.: | | |
| *Cat cracker, bbl. per day | 5,000 | 1954 |
| ‡Cat reformer, bbl. per day | | |
| ‡Coker, bbl. per day | | |
| *Crude cap. increase, bbl. per day | 6,500 | 1954 |
| *Alkylation unit, bbl. per day | 500 | 1954 |
| Texas Co., El Paso, Tex.: | | |
| *Cat cracker, bbl. per day | 5,000 | 1954 |
| *Crude cap. increase, bbl. per day | 4,500 | 1954 |
| ‡Cat reformer | | |
| ‡Coker | | |
| Trans-Marine Oil Refg. Corp., Milwaukee: | | |
| ‡New refinery | | |
| United Refg. Co., Warren, Pa.: | | |
| *Cat reformer, bbl. per day | 2,500 | 1953 |
| Wesco Refg. Co., Rangeley, Colo.: | | |
| *Cat cracker, bbl. per day | 1,150 | Late '53 |
| Western States Refg. Co., N. Salt Lake City, Utah: | | |
| *Crude cap. increase, bbl. per day | 1,000 | 1953 |

*Building. †Authorized. ‡Planned. §Contracted.

## Shutdown Plants in Canada

| Company and plant location— | Refinery type | Cap., bbl. per day: Crude oil | Cap., bbl. per day: Cracking |
|---|---|---|---|
| Home Oil Distributors, Ltd, N. Vancouver, B. C. | S | 2,000 | |
| Lion Refg. Co., Ltd., Calgary, Alta. | S | 750 | |
| Trump Oil Co., Morris, Man. | S | 300 | |
| Total | | 3,050 | |

## Summary of Refineries in Mexico

| | No. plants | Bbl. daily: Crude oil capacity | Bbl. daily: Cracking capacity |
|---|---|---|---|
| **Distrito Federal** | **1** | **52,000** | |
| **Guanajuato** | **1** | **30,000** | **4,500** |
| **Tamaulipas** | **3** | **98,000** | **20,500** |
| **Veracruz** | **3** | **43,000** | **6,000** |
| **Total** | **8** | **223,000** | **31,000** |

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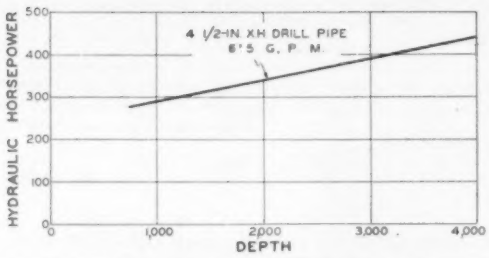


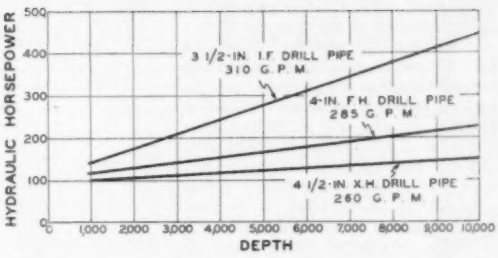


**HYDRAULIC HORSEPOWER REQUIREMENTS for effective use of jet rock bits in West Texas area: Fig. 1—(Left) Example using 300 ft. of 7¾ by 2¾-in. drill collars in a 11-in. hole. Fig. 2—(Right) Example using 450 ft. of 6 by 2¼-in. drill collars in a 7⅞-in. hole. (In both cases, nozzle velocity was 225 ft. per second, the annular velocity 150 ft. per minute, and the mud weight 9.5 lb. per gallon.)**

# Today's Techniques Speed West Texas Drilling

## . . . and result in straighter holes along with greater economy

**by David Johnston and W. R. Johnston**

BECAUSE drilling in the Permian basin is slow and expensive and because so many rigs are operating in the area, there has been much interest in advances in drilling practices which tend to increase drilling rates and decrease rig operating costs. Interchange of ideas and information between operators is widespread through such mediums as the A.P.I. Committee on Drilling Practice.

**Weight on bit . . .** In 1947 some of the early results of high weight-drilling were discussed at the spring meeting of the Southwestern District, A.P.I. Division of Production.[1] It was pointed out at that time that maximum bit weights seldom exceeded 5,000 lb. per inch of bit diameter. This weight limit is still generally observed, with the possible exception of larger-sized bits, because experience has been that higher weights lead to premature bit failure. Also, there has apparently been no economical increase in penetration rate with higher bit weights.

It also was noted at the same time that the use of high bit weights had brought about several problems. Among these were: (1) use and care of long drill-collar strings; (2) fishing for drill collars and cones; and (3) an increased tendency toward hole deviation with high bit weights. The first two problems, use of long collar strings and fishing for drill collars, turned out to be closely related. Several interrelated ideas and procedures have developed which have materially reduced the incidence of drill-collar failure, and thus reduced the fishing hazard. Most important has been the routine inspection of drill collars, primarily by magnetic-particle inspection, for cracks in threads to eliminate bad joints prior to failure in the hole. It is difficult to estimate the number of fishing jobs that have been prevented by drill-collar inspection, but certainly each operator can recall several instances of discovery

Authors are with Humble Oil & Refining Co. at McCamey and Midland, Tex., respectively. Paper presented at A.P.I. Southwestern District Division of Production, Fort Worth, March 4-6, 1953.

**TABLE 1—JET VS. CONVENTIONAL ROCK BITS—12¼-IN. SURFACE HOLE**

| | Yarbrough & Allen field | | Other operators | |
|---|---|---|---|---|
| Well— | Y & A 31 | Y & A 32 | | |
| Depth | 185-3,550 | 180-3,547 | 320-3,533 | 305-3,539 |
| Footage | 3,345 | 3,367 | 3,213 | 3,234 |
| Bits | *7 | *6 | *6 | †13 |
| | | | †4 | |
| Rotating hours | 99¼ | 91 | 141 | 180¾ |
| Feet per hour | 33.7 | 37 | 22.8 | 17.9 |
| Feet per bit | 478 | 561 | 321 | 249 |

*Jet. †Conventional.

**TABLE 2—JET VS. CONVENTIONAL ROCK BITS—11-IN. SURFACE HOLE**

| | | Other operators | | |
|---|---|---|---|---|
| Well— | Y & A 33 | | | |
| Depth | 173-3,545 | 305-3,425 | 306-3,400 | 280-3,563 |
| Footage | 3,372 | 3,120 | 3,094 | 3,283 |
| Bits | *6 | *7 | *4 | †14 |
| | | †3 | †5 | |
| Rotating hours | 91¾ | 114½ | 118¾ | 182½ |
| Feet per hour | 36.8 | 27.2 | 26.1 | 18.0 |
| Feet per bit | 562 | 312 | 344 | 235 |

*Jets. †Conventional.

**TABLE 3—JET VS. CONVENTIONAL ROCK BITS—LIME SECTION, 8¾-IN. HOLE**

| | Yarbrough & Allen field | | Other operators | |
|---|---|---|---|---|
| Well— | Y & A 32 | Y & A 25 | | |
| Depth | 3,547-7,585 | 3,555-7,457 | 3,535-7,517 | 3,539-7,436 |
| Footage | 4,038 | 3,902 | 3,982 | 3,897 |
| Bits | *17 | *15 | †24 | †31 |
| | †1 | | *1 | |
| Rotating hours | 271½ | 264½ | 263 | 254½ |
| Feet per hour | 14.9 | 14.8 | 15.1 | 15.3 |
| Feet per bit | 224 | 260 | 159 | 126 |

*Jets. †Conventional.

of incipient failure on the rack before failure occurred in the hole.

In addition to inspection, in the past 4 or 5 years there has been more widespread interest in the development and use of properly balanced drill-collar box and pin sizes and in the stress relieving of drill-collar connections. It is probable that this latter design feature has been of more significance in increasing drill-collar connection life than have changes in thread design or work hardening of thread roots, both of which have received much comment in recent years. In any event, all of these procedures have tended to reduce the chances of a drill-collar fishing job.

Should a drill-collar fishing job occur, the development of very satisfactory "free point" indicators and the use of the string-shot technique in connection with the indicators has made fishing for long drill-collar strings much less hazardous.

Although no figures have been assembled on loss of bit cones, it is believed that slower rotary speeds, on the order of 60 r.p.m. or less, have reduced loss of bit cones. Development of special cone baskets, the use of heavy mills to break up cones, and the development of magnetic fishing tools have all tended to reduce the fishing hazard.

Hole deviation is still very much of a problem and is discussed in more detail later herein.

### Developments in Bits

During the past 2 to 3 years two types of rock bits have become important in West Texas, viz., the jet rock bit using high nozzle fluid velocities, and the "chert bit" with sintered tungsten carbide inserts. Although neither bit is suitable for use on all rigs in all situations, both have been used with sufficient success to merit discussion.

**Jet rock bits . . .** Initial experimentation with the jet-bit principle in West Texas began as early as 1938. Water courses were added to bits and/or shrouds were installed between the cones with the idea of directing the fluid to the bottom of the hole. These early experiments and some as late as 1947 indicated no noticeable improvement in bit performance and, consequently, experimentation ceased.

Success of the jet drag bit and, shortly afterward, the jet rock bit in the softer areas led several West Texas drillers to active testing of the jet rock bit approximately 2½ years ago. Results were promising enough that during the past 20 months Humble Oil & Refining Co. rigs in West Texas have been using all jet rock bits within the limitations of the supply of integral jet bits and jet rock bit subs. The availability of integral jet bits is increasing steadily.

**TABLE 4—JET VS. CONVENTIONAL ROCK BITS—LIME SECTION—HOURS PER BIT—8¾-IN. HOLE**

| | Yarbrough & Allen field | | Other operators | |
|---|---|---|---|---|
| Well— | Y & A 32 | Y & A 25 | | |
| Depth | 3,547-7,585 | 3,555-7,457 | 3,535-7,517 | 3,539-7,436 |
| Footage | 4,038 | 3,902 | 3,982 | 3,897 |
| Bits | *17 | *15 | †24 | †31 |
| | †1 | | *1 | |
| Rotating hours | 271½ | 264½ | 263 | 254½ |
| Rotating hours per bit | 15.1 | 17.6 | 10.5 | 8.2 |

*Jet. †Conventional.

**TABLE 5—COST COMPARISON, CHERT VS. CONVENTIONAL BITS—8¾-IN. HOLE**

| Chert | | Conventional | |
|---|---|---|---|
| Cost of one bit | $1,050 | Cost of 2½ bits | $ 389 |
| One trip | 200 | 2½ reamers | 338 |
| | | 2½ trips | 500 |
| Total | $1,250 | Total | $1,227 |

The evaluation of jet rock bits in West Texas has been more or less puzzling. Humble has had excellent results using jet rock bits, but it also adopted the use of oversize drilling collars and slower rotary speeds at about the same time, either of which may have materially aided bit performance. In addition, its rigs are equipped with pumps capable of putting in excess of 700 hydraulic horsepower into the hole. Nevertheless, there is no question in the minds of the people operating these rigs that the jet rock bit has improved drilling rate and reduced the number of bits.

Tables 1, 2, and 3 compare the use of jet and conventional rock bits in Yarbrough and Allen field. In the 12¼-in. and 11-in. surface holes, use of jet rock bits has increased the rate of penetration as much as 100 per cent and reduced the number of bits required by 50 per cent. This increase in bit performance is largely attributed to the higher bit weights that are possible when using jet bits.

In the 8¾-in. hole through the Permian lime section, the two jet-bit-drilled holes shown in Table 3 had a slightly slower rate of penetration, but the number of bits required was reduced by as much as 50 per cent. The over-all rig time required was considerably less on the jet-bit-drilled holes, and the reduction in bits alone more than paid for the 15 to 20 per cent additional cost of the jet bits. Improvement in bit performance with the jet rock bit in Yarbrough and Allen field has been consistently good in all hole sizes.

Other operators have met with varying success with the jet rock bit. In general, those having adequate hydraulic horsepower available for use at the bit are using jet rock bits in the softer formations and are reducing over-all drilling time. Many others have tried the bits and have not shown enough improvement to convince them that the bits justified their use.

There are several possible reasons why the average West Texas driller has not readily accepted the jet rock bit. In the first place, the average West Texas rig has 250 to 300 hydraulic horsepower available for fluid circulation. In a 12¼-in. hole at 3,000 ft. with 4½-in. drill pipe and 450 ft. of 2¾-in. bore drill collars, approximately 1,150 hydraulic horsepower is needed to maintain an annular velocity of 175 ft. per minute and a jet nozzle velocity of 250 ft. per second. There are probably no rigs in West Texas capable of delivering 1,150 pump horsepower. Good jet-bit results may be obtained by reducing annular and nozzle velocity, but not to the range where 250 hydraulic horsepower will permit effective jet-bit operations in a 12¼-in. hole.

On the other hand, 250 hydraulic horsepower would be adequate in 6¾, 7⅞, and 8¾-in. holes to depths of 7,500 ft. or more, provided 4-in. o.d. or 4½-in. o.d. drill pipe is used with drill collars having a bore of 2¼-in. or larger, preferably larger.

Many West Texas operators feel that only rigs with extremely large pumps can properly use jet bits. This is not correct for the average West Texas hole program. Figs. 1 and 2 illustrate the hydraulic horsepower requirements for an 11-in.-7⅞-in. hole program, which is a common program in the area. An annular velocity of 150 ft. per minute and a nozzle velocity of 225 ft. per second are assumed, and it is believed are adequate for good jet-bit results. Referring to Fig. 1, which is for an 11-in. hole using 4½-in. extra-hole drill pipe and 300 ft. of 7¾-in. o.d. by 2¾-in. i.d. drill collars, it is noted that approximately 290 hydraulic horsepower is needed at 1,000 ft. and some 50 additional hydraulic horsepower per additional 1,000 ft. of hole. A typical West Texas program calls for 1,800 ft. of 11-in. hole, which

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NOTES ON

## Ethylene

The world's first naphtha pyrolysis and purification plant for the production of high purity ethylene has now been on stream in England for well over a year. A second is under construction in Italy.

***

*Both were designed by Kellogg. The one in England has consistently produced high yields of ethylene with a purity of 99.9%. Loss during low temperature fractionation is less than 3%.*

***

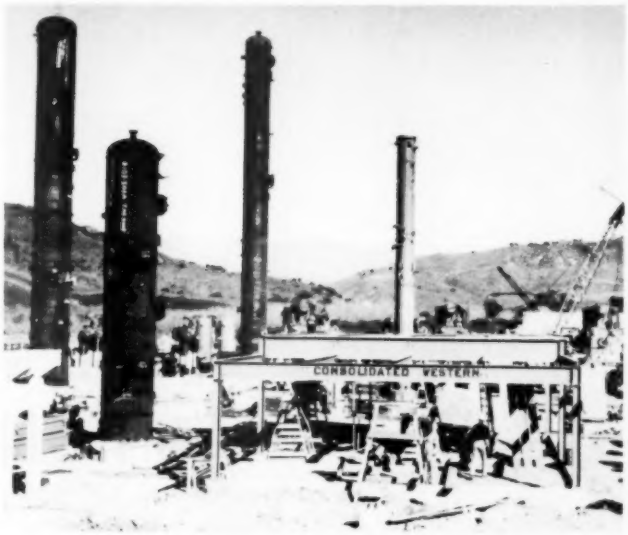
Of particular interest is the fact that the C-3 product made as a bottoms stream from the deethanizer contains 93–97% propylene . . . indicating the high selectivity of the cracking process for olefin production. This by-product is suitable for chemicals production at high efficiency without fractionation between propylene and propane.

***

*Actually the plant may be operated under different conditions to produce olefins in varying proportions. This has been well demonstrated in work done over a number of years in Kellogg's naphtha pyrolysis pilot plants. Such flexibility would be particularly important to the processor whose markets for various olefins might change in accent.*

***

Current interest in naphtha pyrolysis as the prime step in producing high yields of olefins is largely restricted to processors abroad. Domestically, heavy gas oil will probably become important as a charge stock.




# High Pressure Gas Reforming Slated for West Coast Ammonia Unit

A special high-pressure gas reforming plant will be the feature of a new ammonia plant Kellogg is currently erecting for a West Coast processor. Shown here during construction, the unit will produce well over 300,000 pounds of anhydrous ammonia daily from a natural gas feed stock.

The result of pilot plant studies by Kellogg, the reformer section of the plant makes use of the fact that natural gas is usually available at relatively high pressure. Rather than design the reformer for operation at conventional low pressure and thus produce low pressure synthesis gas, Kellogg engineered this section to conserve the potential energy of the natural gas. Although the synthesis gas must be still further compressed before it is charged to the converter, the new high pressure reformer will save about 25% to 35% on compressor horsepower.

In addition to the gas plant, the ammonia unit includes the Kellogg reactor, which is especially designed to maintain optimum conversion temperatures.

Close control of temperatures is extremely important to this process. To attain a reaction rate high enough to be economic, temperatures must closely approach the point at which catalyst activity deteriorates rapidly and at which construction materials are attacked at an appreciable rate.

Therefore, in the ideal ammonia converter, it is essential to remove excess heat as rapidly as possible from every point where exothermic reaction occurs. Since these points "move about" through changes in the conditions of operation and through aging of catalyst, the design of an economical converter that completely solves the problem of excess heat removal, when and where it is produced, has posed a difficult problem.

However, the new Kellogg converter which employs layers of catalyst with an efficient means of cooling the gases in between, closely approaches the ideal point-by-point temperature control.

In addition to the plant now going up on the West Coast, Kellogg has designed several others with conventional reformers but with the special reactors. Three large ones were built virtually simultaneously during World War II. Since they have been in operation they have continued to maintain the highest efficiency levels in the industry.

(SEE REVERSE SIDE)

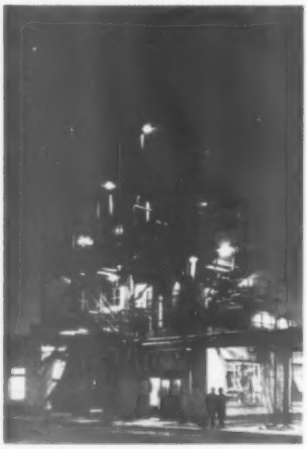
CONTINUED FROM PRECEDING PAGE



## New Phthalic Plants Incorporate Recent Improvements

First to be built since the initial commercial plant was designed for a major U. S. processor, two new Fluid phthalic anhydride plants are now underway for two important chemicals companies in England and Italy.

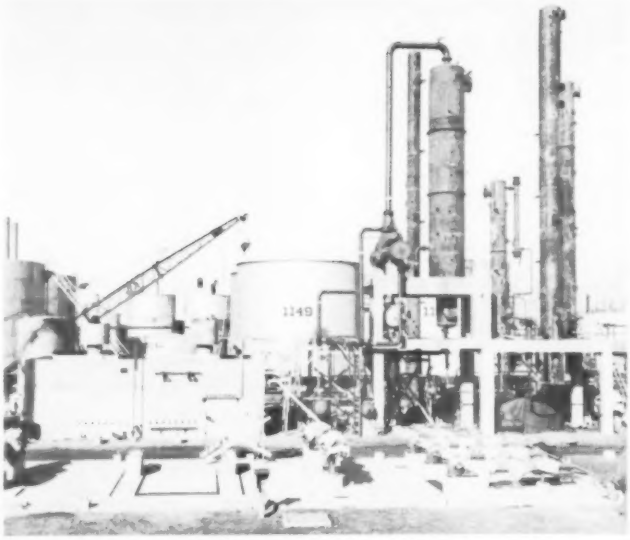
Several design improvements are being incorporated in these new plants. Most important is a re-design of the condensing system which not only decreases capital investment but also improves actual operating conditions. It precludes, for example, any need for operators to come in direct contact with the phthalic or its fumes.



*First Kellogg Fluid Phthalic Anhydride Plant*

Between them the two plants will produce about 50 million pounds of phthalic anhydride annually. The product in this process is produced by the oxidation of naphthalene in the presence of fluidized solid catalyst.

Meanwhile, in view of the domestic irregularity of supply of naphthalene, Kellogg is continuing its study of the possibilities of using other feeds for this process. While no conclusive data is yet available, other feed stocks are currently being viewed by the industry as a whole with considerable interest: alpha-methyl-naphthalene, ortho-xylene and others. Since the first of these materials is produced as a by-product of both Fluid catalytic cracking and Hydroforming it appears to meet constant availability requirements.



## New Iso-Octyl Alcohol Plant Progresses

Engineered by Kellogg, this new iso-octyl alcohol plant is scheduled for completion this year. The vessels on the concrete structure at the right are the alcohol, alcohol re-run and aldehyde towers. They comprise only a small portion of the complete unit.

Kellogg is also currently designing several different types of alcohol plants for other processors. These include units for the production of a wide range of alcohols.

### Typical Current Kellogg Chemical Plant Contracts

- ★ Phenol-from-cumene (2)
- ★ Iso-octyl-alcohol
- ★ Ethylene
- ★ Ammonia
- ★ Phthalic Anhydride (2)
- ★ Glyceride Purification
- ★ Liquid Fuel and Chemicals Synthesis from Coal

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would require a maximum of 350 hydraulic horsepower. Many West Texas rigs have one pump, or two pumps capable of parallel operation, which will furnish this amount of hydraulic horsepower and consequently could use jet bits.

Referring to Fig. 2, which is for a 7⅞-in. hole using 450 ft. of 6-in. o.d. by 2¼-in. i.d. drill collars, it is noted that the hydraulic horsepower requirements are shown for three sizes of drill pipe. The total depth of an average West Texas well is around 8,000 ft. Only 140 hydraulic horsepower is needed at that depth with 4½-in. extra-hole drill pipe and 205 hydraulic horsepower with 4-in. full-hole drill pipe, both of which are in the power range of practically all rigs in the area. With 3½-in. I.F. drill pipe, the hydraulic horsepower needed jumps to 375 which is out of the range of most area rigs primarily because a pump pressure of around 2,000 psi. would be needed.

The improvement with jet rock bits in the average small hole is difficult to recognize, primarily because the improvement comes in increased bit life. There are numerous cases where jet rock bits have been run in the lower Permian and some deeper sections under maximum weights for periods as long as 20 to 25 hours. In these sections 2 years ago average bit life was 6 to 12 hours. It is difficult for many drillers to realize that bit performance can be improved by leaving a bit in the hole, especially when they have become accustomed to short bit life.

Table 4, which uses the same data from Yarbrough and Allen field as did Table 3, illustrates the increase in bit life possible with jet bits. In this case the minimum increase is 50 per cent and the maximum exceeds 100 per cent. This is probably one reason why some drillers have not been satisfied with jet rock bits even though the horsepower was available. A rotary torque indicator is very helpful in determining when to pull a jet rock bit in all but the very abrasive formations. It has also been noticed that slow rotary speeds are effective with jet bits, and may be a decided factor in the bit-life increase.

Another factor which has hindered improvement with the jet bits is the widespread use of 3½-in. drill pipe and 2-in. or 2¼-in. bore drill collars. Some West Texas operators are using, and more are contemplating the use of 4-in. o.d. drill pipe which has a tool joint only slightly larger than 3½-in. drill pipe. The 4-in. drill pipe can be used safely in 6¾-in. hole and is considered safe by some operators for use inside of 7-in. casing. As shown in Fig. 2, an additional 170 pump horsepower is required for jet-bit operation at 8,000 ft. with 3½-in. drill pipe when compared with 4-in. drill pipe. Inasmuch as the nominal weight of 4-in. drill pipe is 14 lb., compared with 13.30 lb. for 3½-in., the increase in hook load at 8,000 ft. would be small.

Drill-collar bore can also be very critical. Assuming a rig pumping 300 g.p.m. through 600 ft. of 2-in. bore drill collars, 82 hydraulic horsepower would be required just to pump through the collars. If the bore were increased to 2¼-in., the hydraulic horsepower required would be reduced to 48 and with a 2½-in. bore to 28 hydraulic horsepower. The loss in weight of the collars would be only 6 lb. per ft. if the bore were increased from 2 in. to 2½ in.

All of the factors mentioned have contributed to the problem of evaluating the jet rock bit in West Texas. Based on Humble's experience, jet-bit performance in West Texas may be evaluated as follows:

From the surface through the red beds, salt, and anhydrite section to the San Andres formation, results have been good with increases in penetration rate as much as 50 per cent and a reduction in the number of bits by as much as 50 per cent. From the San Andres to the Devonian, no readily apparent increase in penetration rate, but a reduction in the number of bits by as much as 50 per cent. From the Devonian through the Montoya, no conclusive data; but the drilling of this section is not as great a problem since the advent of the tungsten carbide chert bit. From the Montoya into the Ellenburger, enough increase in both bit life and penetration has been noted to justify the use of the jet rock bits.

**Chert bits . . .** Probably the most important improvement in hard-formation bits for the past decade has been the development of the chert bit. The chert bit is a prime example of the old adage "never judge a book by its cover." When the bit companies were conducting initial tests with the bit about 2 years ago, most drillers expressed positive opinions as to how much hole that bald-headed dull bit would make. They were pleasantly surprised to discover that the bit would drill on an average of 5 to 7 times as much hole as a conventional bit and, in many cases, 10 to 20 times as much.

Chert bits are expensive, costing around $1,050 in the 8¾-in. size. The payout of the bit depends on the operating cost of the rig involved, amount of hole made with conventional bits, amount made with the chert bit, and whether reamer cutters can be omitted using the chert bit. One operator using a $50 per hour rig and no reamers with the chert bit estimates that the bit pays out if it makes as much hole as two and one-half bits. This is arrived at as shown in Table 5, assuming the penetration rate of both chert and conventional bits is the same, which is usually true.

Various costs may raise economical rates for the bit or even lower it at depths requiring slow trips; but in general, in formations containing 30 per cent chert or more, the bit can be used economically when conventional bit performance drops below 20 ft. per bit. In any formation it is worth trying when conventional bit performance drops below 15 ft. per bit. On a recent Humble well in eastern Andrews County, 8¾-in. bit performance was poor in the Mississippian at around 12,000 ft. Bits were making only 10 to 25 ft. and the formation was hard lime with a small amount of chert. The first chert bit made 93 ft. in 34 hours and the second made 100 ft. in 35 hours. The bits were run with 30,000 to 35,000 lb. at 30 to 35 r.p.m.; and, considering the trip-hours saved, their use was certainly justified.

There are many possible variations of the chert-bit construction, and it is believed that types of the bit will be developed that will reduce drilling time in all hard formations. The present bit utilizes spherical-nosed compressed tungsten carbide teeth and is effective in the very brittle formations that will drill by crushing. It is possible that sharp tungsten carbide teeth will cut the so-called tough formations such as the slow-drilling deep shales. Other possible variations are the use of the carbide compacts in the reaming edge of conventional hard-formation bits and a combination of carbide teeth and sharp conventional teeth on a bit to drill the broken chert and lime or shale formations often encountered in West Texas.

The chert bit has been used to drill broken formations in the following manner. As long as the drilling time stays normal for chert formations (5 ft. per hour) the chert bit is used. If the rate slows, indicating shale or lime, the bit is pulled and a conventional bit is run until chert is encountered again. Experience is needed in an area to use the chert bit economically in this manner, but it does illustrate the possibility of the development of a bit using a combination of conventional teeth and the tungsten carbide compact teeth. Future development of bits using compressed carbide and possibly other met-

als will certainly reduce hard-formation drilling problems.

### Straight Hole

It is estimated that at least 20 per cent of the holes drilled in West Texas are drilled with reduced weight through one or more sections because of crooked hole. The crooked-hole problem has increased with the trend toward high bit weights and is now at the point where a great deal of experimentation is being carried on in an effort to combat crooked hole.

Most operators are using some forms of stabilization. Some are stabilizing through the use of reduced bit weight and, consequently, have less buckling in the drill-collar string; but this method is expensive because of the reduction in penetration rate with light weight. Others are using string reamers with smooth rollers placed at various places in the drill-collar string with the idea of reducing buckling. A common method of placing the stabilizers is to notice the shiny areas in the collar string and to install the reamers at these points, with the idea that the shiny areas are caused by the collars contacting the walls of the hole.

Many operators are trying the various types of sleeve stabilizers now on the market. Either a bottom collar, usually equipped with four sleeves, or a sub with one sleeve is used or sometimes both. In fact, practically every conceivable combination of reamers, stabilizers, and sleeve-type stabilizer has been tried.

An increasing number of operators are using large drill collars. Humble has adopted the practice of using fifteen 7¾-in. collars in 8¾-in. hole; fifteen 7-in. collars in 7⅞-in. hole, and eighteen 6-in. collars in 6¾-in. hole in all areas where the salt section is cased off and no abnormal drilling problems are expected. Several others use a combination string of three or more oversize collars directly above the bit, with the remainder of a size capable of being washed over. There is a definite trend toward larger collars, e.g., the use of the 7-in. collar in 8¾-in. hole. Seven-inch collars can be washed over (8⅛-in. o.d. flush joint) in short intervals and offer better stabilization than the commonly used 6¼-in. collar, and also can have a 2¾-in. bore which reduces the hydraulic losses.

Two interesting facts concerning large drill collars have been noticed recently. In a recent A.P.I. committee meeting where a number of operators using oversize collars and full-gage sleeve-type stabilizers were represented, fishing for oversize strings was discussed. Not one operator has lost or had heard of anyone else losing a string of oversize collars in the West Texas area, nor had any operator found it necessary to wash over a sleeve-type stabilizer. Undoubtedly large collars have been and will be lost in West Texas, but it does appear that the possibility of losing oversize collars is considerably less than generally assumed by most operators. The average fishing job with oversize bottom assemblies is stuck pipe, and is cleared up with the use of oil or a backoff shot and subsequent use of jars. In cases of drill-collar joint failure, a tapered tap may be used or a fishing neck can be cut with a diamond shoe to enable the use of an overshot.

Humble has used a string of fifteen 7¾-in. collars in 8¾-in. hole for 20 months without a collar failure; and recently it was found the average outside diameter of the collars is now 7⅝ in. This may be compared with the accepted average collar wear using smaller collars, which is ¼ in. of diameter per year for the West Texas area. This low rate of outside-diameter wear with larger collars is probably a result of reduction in buckling over smaller collars, reduced rotary speeds, and possibly because the high velocity of the mud in the restricted annulus with the large collars exerts some force to keep the collars from rubbing the walls of the hole.

**Percussion . . .** In addition to stabilization, one other method of combating crooked hole shows some promise. Percussion drilling has been experimented with for a number of years and has shown some tendency to drill a straight hole. However, only a few percussion-type drilling tools have been developed to the stage that they could be used for drilling enough hole to evaluate their straight-hole drilling or hole-straightening properties. Recently one tool has been developed by a major bit company which shows promise of being an aid to straight-hole drilling. Recent field tests have indicated that, at least in some areas, holes can be straightened with this tool and still maintain a reasonable rate of penetration. Another year should see a full evaluation of this and possibly other percussion-type tools.

### Drilling Equipment

Air slips are now fairly common on the heavy rigs and, although some operators disagree, most feel that the safety features and labor saving of the air slips result in an over-all increase in rig efficiency which will justify the cost of power slips.

As previously mentioned in the jet-bit discussion, rotary-table torque indicators are an aid in determining the time to pull a bit. An increasing number of rigs are being equipped with some type of torque indicator, either a vacuum gage in the case of gas engines, or a rotary chain tension indicator for diesel-powered rigs.

**Drilling feed-off control** or so-called automatic driller has proved to be a valuable aid in increasing penetration rates and thereby reducing drilling costs. A recent survey indicated that there were 67 rigs operating in West Texas with some type of feed control. Most of the controls are used on rigs rated as 9,000 ft. or deeper, and inasmuch as there are approximately 300 rigs of that size in West Texas, some 22 per cent of the heavy rigs utilize the drilling-feed control.

One good comparison of rigs using the drilling-feed control occurred in Yarbrough and Allen field. Eleven wells drilled over a 2-year period were compared. All used essentially the same drilling practice with the exception that six were drilled by rigs without feed controls and five by rigs with a drilling-feed control. The five wells drilled by rigs with feed controls averaged 276 rotating hours less per well than the average of the six wells drilled without feed controls, which amounted to a reduction of 18 per cent in rotating time. A reduction in rotating time of this order certainly justifies the cost of a feed control. In addition to the reduction in rotating time, a minimum of twistoffs and crooked-hole difficulty was experienced by the rigs using the feedoff device.

Interest in automatic pipe-handling equipment is increasing. Several air-powered drill-pipe spinning tongs are now in use and automatic catheads are used practically universally. Humble's automatic rig has been in operation in West Texas for over a year. Although continued development with the equipment is necessary for it to replace conventional equipment, the equipment does handle pipe as fast and is capable of handling pipe faster than conventional equipment. The pipe is handled with a minimum of effort and offers a very safe method of handling drill pipe because no catheads are used and no personnel are near the drill pipe.

### Results of Improved Drilling Practice.

In Yarbrough and Allen field, some 60 wells have been drilled by several operators. In mid-1951 Humble initiated a program to reduce drill and complete time and total well cost in the field. At that time Humble had drilled 20 wells with an average completion time for normal field wells of 110 days. The following practices were initiated: oversize drill collars, jet rock bits, reduced rotary speeds, chert bits,

and predrilled mouse and rat holes to reduce spudding time.

The two rigs used are equipped with drilling-feed controls and are unitized for skidding and are able to skid and set surface pipe in less than 24 hours. The results of this program have been encouraging. The record time for the field was lowered to 94, 86, and 81, and on the latest well to 70 days' total time from skid to skid. The best completion time reported by other operators is 98 days, with an average time of from 100 to 110 days.

### Future Trends in Drilling

There are some definite trends in West Texas drilling operations that appear to prognosticate future drilling practices and equipment. One of the most probable is the use of air or gas as a circulating medium. Remarkable results have been obtained, mostly in the San Juan basin of New Mexico; and with an estimated 20 per cent of the West Texas footage capable of being drilled with a gaseous medium, progress in this field is certain to advance. There are numerous indications of equipment changes: larger drill pipe; maximum-size drill collars in known areas and maximum to wash over in other areas; maximum-bore collars to reduce hydraulic losses; extensive use of jet-type bits; power pumps with greater horsepower; gas engines with more horsepower; and a tendency away from diesel engines because of the low cost of butane; an increasing use of air-powered automatic equipment and automatic drilling-feed controls.

Wells have been drilled to depths of over 15,000 ft. in the area, and deeper tests are not far in the future. Abnormal pressures, although not as great as coastal pressures, have been encountered which will necessitate some revision in the usual West Texas casing program.

To control any abnormal pressure in West Texas, it is necessary to have a string of casing set through the usual lost-circulation zones. In the deeper areas, this would require from 10,000 to 12,000 ft. of casing. The cost of drilling a 12¼-in. hole to set 9⅝-in. casing or an 11-in. hole to set 8⅝-in. casing at these depths would be practically prohibitive. It seems likely that future deep tests will carry 8¾-in. hole, and if a deep protective string is needed, will use 7⅝-in. slim hole or 7-in. casing and drill to total depth with a hole size from 6¾ to 6-in. It is common practice in the West Texas area to set 5½-in. casing in 6¾-in. hole; and it is possible to set 5-in. casing in 6-in. hole.

### Reference

1. Johnston, David: Hard Rock Drilling in the Permian Basin, Drilling and Production Practice, 50 (1947).

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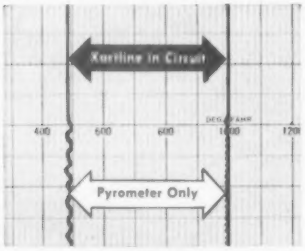


*Exact reproduction of temperature chart for a heating process showing the comparison of the "Straight-Line" temperature control produced by XACTLINE and the saw-tooth curve obtained with only conventional control.*

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## ON THE JOB . . . . . IN THE PLANTS

**B. G. MARTIN AND W. H. STILL of Atlantic Refining Co. examine a combustible gas indicator which they have adapted for use as a special contamination indicator.**

# Contamination Detector

### It solves serious problem of checking contamination of burning oils by gasoline during unloading of tankers

TWO Atlantic Refining Co. men's ingenuity in adapting a standard combustible gas indicator as a special contamination indicator has solved a serious problem of checking the contamination of burning oils by gasoline during unloading of tanker cargoes.

B. G. Martin and W. H. Still, of the company's Point Breeze refinery, worked out scales which convert the usual combustible gas indicator so it can test samples of fuel oil or kerosine and immediately trace the slightest percentage of gasoline contamination. This eliminates the lengthy "flash point" tests which cannot be carried on within the vicinity of unloading tankers or barges.

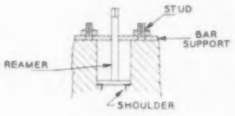
**Big problem . . .** Many of Atlantic's vessels load and discharge three different grades of products simultaneously, and, pumping at the rate of 12,000 bbl. per hour or more, extremely serious contamination could occur in a short time. In fact, during the time formerly needed to carry samples to a laboratory and run complicated flash tests, many barrels of product could be spoiled.

**Saves material . . .** The new process, with which an operator can check contamination in a matter of seconds, saves substantial amounts of material in event of leakage. It is especially valuable in pipe-line operation and doubly assures purity of the company's products.

The two graphs developed by Martin and Still convert standard combustible gas indicator readings to an equivalent flash point and contamination index number for either kerosine or fuel oil—immediately showing any traces of gasoline that may have entered the product.

## Reamer for Seating Valves

A reamer for seating valves has been constructed from spare parts at the machine shop of the Wardner plant of

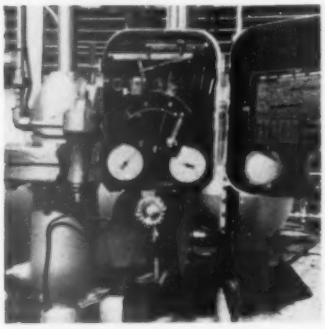


The Chicago Corp. in Agua Dulce field, South Texas.

The tool consists of a cutting end mounted on an old polish rod for reaming the valve shoulder. The rod is cut square at one end to allow a wrench or power drive to be attached to provide rotary motion to the reamer.

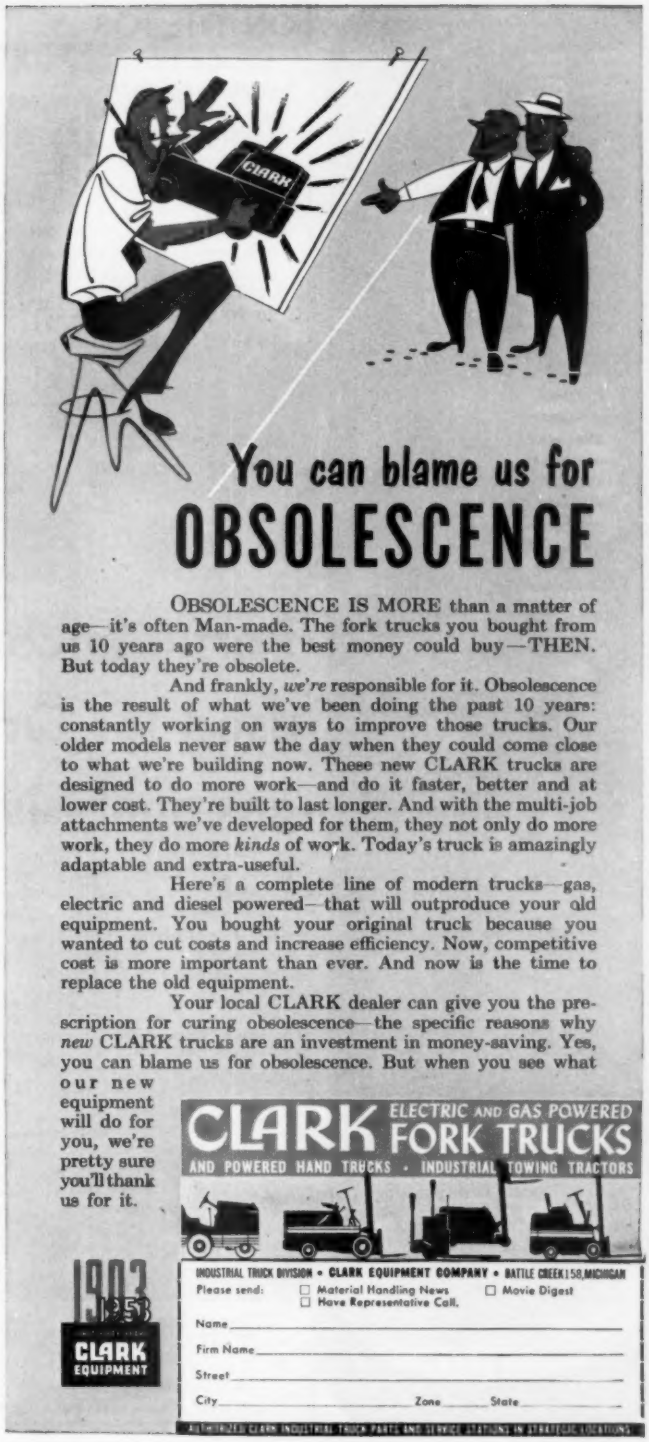
**PLANT FOREMAN H. Wallace holds reamer for seating valves.**

In addition, a piece of bar metal slides over the shaft and attaches to stud bolts on the compressor being overhauled. The reamer is thus securely supported so that it will not deviate from making a true cut on the shoulder.



## Motor Valve Heater Coil

**In examining the cause of freeze-ups of motor valves, during cold weather, it was discovered at one gasoline plant that a large part of the difficulty was caused by moisture getting to the diaphragm and bourdon tubing of the pressure controller, although air and gas dryers were used. When the moisture froze, it put the pressure controller out of operation, rendering the motor valve inoperative. To solve the problem two holes were drilled in back of the pressure-controller case, one on each side of the diaphragm housing so copper tubing could be inserted through one side, wound around the diaphragm housing, and out the other side. Steam is turned on to flow through the copper tubing, thus keeping the inside of the controller case at a higher-than-outside temperature.**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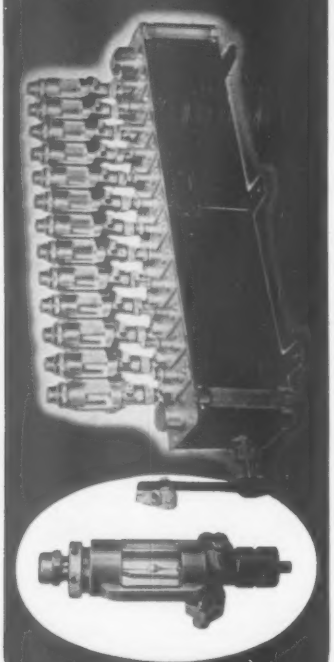

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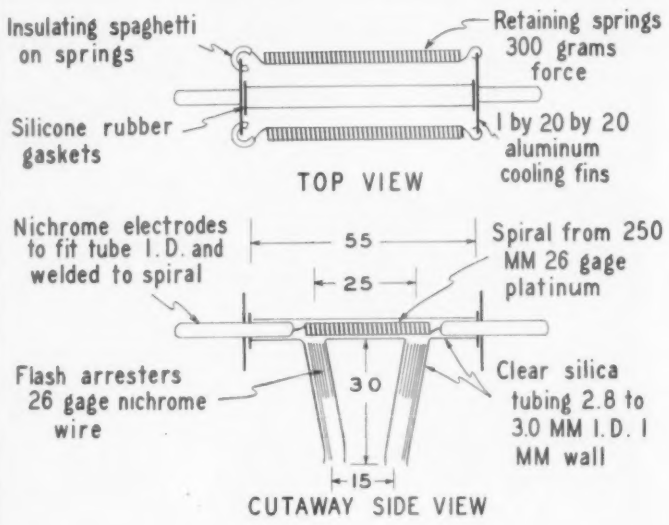
Insulating spaghetti on springs
Retaining springs 300 grams force
Silicone rubber gaskets
1 by 20 by 20 aluminum cooling fins
TOP VIEW
Nichrome electrodes to fit tube I.D. and welded to spiral
55
25
Spiral from 250 MM 26 gage platinum
Flash arresters 26 gage nichrome wire
30
Clear silica tubing 2.8 to 3.0 MM I.D. 1 MM wall
15
CUTAWAY SIDE VIEW

# Portable combustion tube used for Orsat type of gas-analysis apparatus

**Myron L. Robinson***

A COMBUSTION tube, consisting of an electrically heated platinum spiral in a small quartz tube, can be used for rapid, safe, single-pass combustion analysis of natural gas.

*Southern California Gas Co. Adapted from a paper given at the Pacific Coast Gas Association technical services conference, Los Angeles.

Although design has potentialities for use in portable equipment, the application discussed is on a laboratory model Orsat, but a completely portable apparatus for rapid combustion analyses in the field is now being considered.

No simple, safe, reliable apparatus is now commercially available to rapidly burn natural-gas samples for com-

**RESULTS WITH COMBUSTION TUBE ON NATURAL GAS**

| Calculated approximate composition*† | Per cent | Analysis No. | Composition found by combustion,† (per cent) Methane | Ethane | Nitrogen | B.t.u. | Sp. gr |
|---|---|---|---|---|---|---|---|
| Low ethane sample: | | | | | | | |
| Methane | 98.8 | 1 | 98.4 | 0.5 | 1.1 | 1,001 | 0.562 |
| Ethane | 0.2 | 2 | 97.5 | 0.7 | 1.8 | 1,003 | 0.565 |
| Nitrogen | 1.0 | 3 | 99.4 | 0.0 | 0.6 | 1,010 | 0.558 |
| B.t.u. | 1,000 | 4 | 98.7 | 0.1 | 1.2 | 1,003 | 0.560 |
| Sp. gr. | 0.558 | | | | | | |
| High ethane sample: | | | | | | | |
| Methane | 78 | 1 | 77.3 | 17.7 | 4.8 | 1,101 | 0.664 |
| Ethane | 17.5 | 2 | 78.6 | 17.4 | 3.8 | 1,109 | 0.658 |
| Nitrogen | 4.5 | 3 | 77.6 | 17.8 | 4.4 | 1,105 | 0.663 |
| B.t.u. | 1,098 | 4 | 75.9 | 18.6 | 5.3 | 1,103 | 0.670 |
| Sp. gr. | 0.663 | 5 | 78.0 | 17.1 | 4.7 | 1,098 | 0.661 |
| | | 6 | 76.9 | 17.8 | 5.1 | 1,099 | 0.666 |

*Composition based on calorimeter B.t.u. and gravitometer specific gravtiy. †Carbon dioxide, oxygen and other minor constituents not shown.

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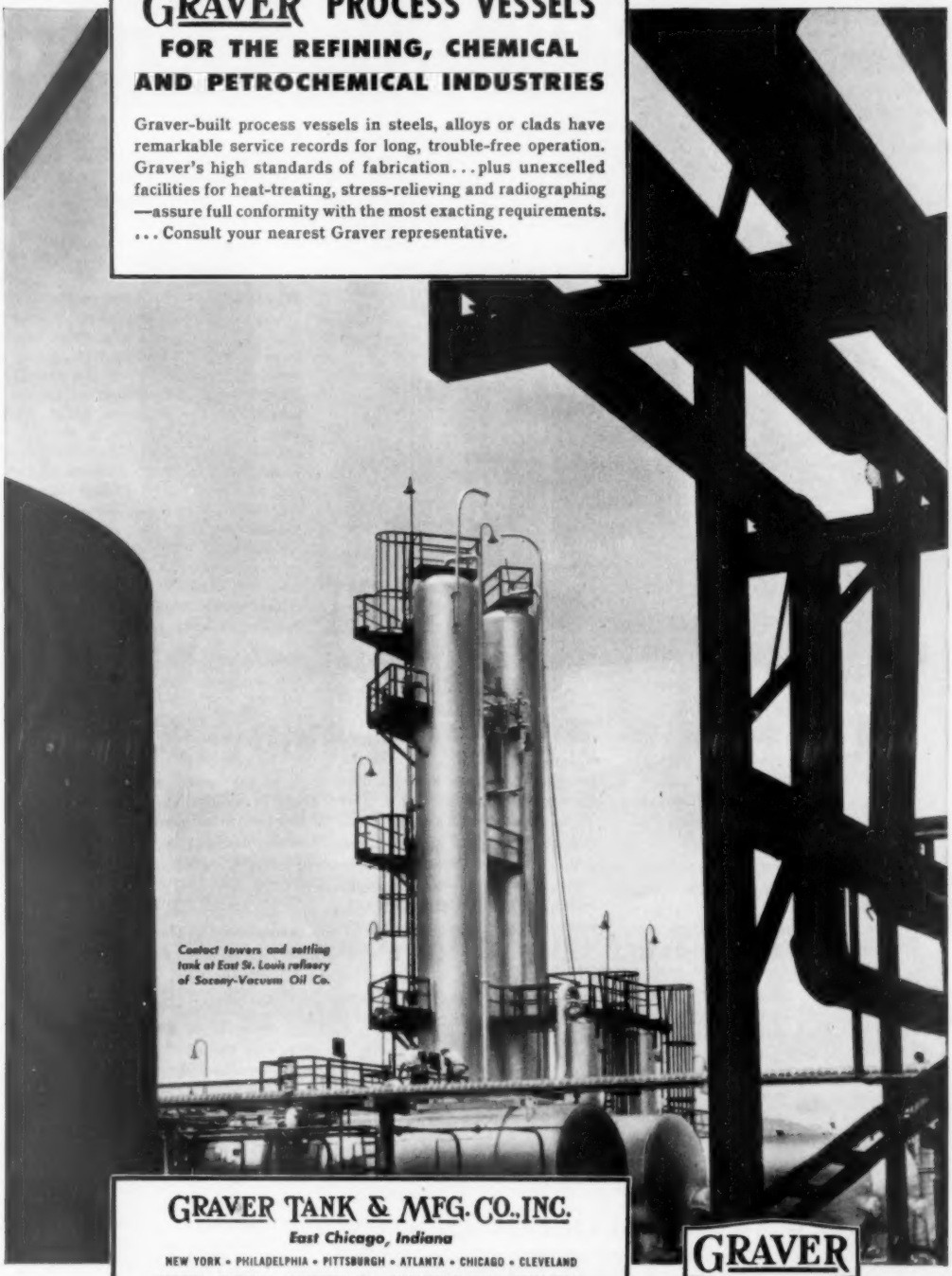

*Contact towers and settling tank at East St. Louis refinery of Socony-Vacuum Oil Co.*

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bustion analysis, and the need is particularly great where portable equipment could be used for on-the-spot analyses such as at leakage investigations.

**Features of combustion tube . . .** Desirable features claimed for the design are as follows:

1. Rapid one-pass combustion of the constituents of natural gas (3 minutes actual combustion time). (If applicable amounts of higher hydrocarbon vapors are present, one or three additional passes are required to desorb the portion on the walls of the apparatus.)

2. Safe combustion even with explosive hydrogan-oxygen mixtures or natural gas containing up to 10 per cent acetylene.

3. Rapid heating (30 seconds) and rapid cooling (1 minute).

4. Low internal volume and surface area keeps the effect of temperature changes and adsorption to a minimum.

5. Fairly simple components that are easily disassembled for thorough cleaning or repair.

6. Stable, durable unit with long life.

7. Not rapidly deteriorated by Orsat fluids.

8. Small and light weight, with no supports required.

9. Low electrical-energy requirements (35 watts for 3 minutes per analysis); batteries may be used for portable field equipment.

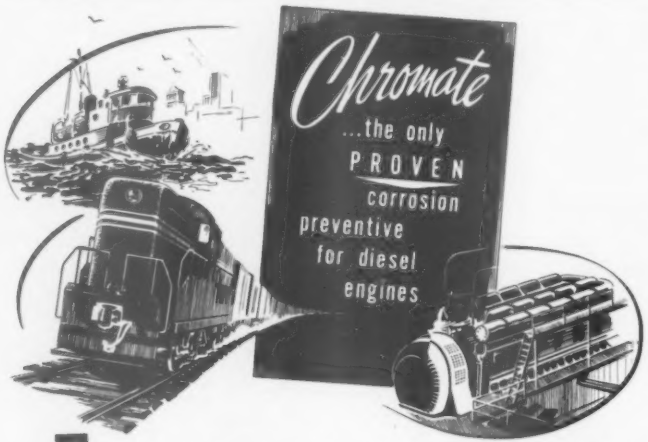
**Principle . . .** The form of the combustion tube adopted, after considerable experimentation with pyrex capillary tubing and cement-type glass-to-metal seals, is shown in the drawing. Basically the unit consists of an electrically heated platinum spiral in a clear silica tube that is in the shape of the Greek letter "Pi." Extending from the horizontal arms of the Pi are electrodes that conduct the current to the platinum spiral which is located between the electrodes. One leg of the Pi is the combustion mixture inlet and the other leg the outlet. Both inlet and outlet contain flash-back arresters which are simply tightly packed bundles of inert wire.

**Construction . . .** Referring again to the drawing, the dimensions shown are not very critical but were chosen for ease of construction and economy of materials and power consumption of the spiral.

In the small size suggested clear silica tubing may be satisfactorily worked in a gas-oxygen flame. The ends of the tube through which the electrodes pass should be ground square on an oil stone in order to make a good seal to the gasket.

**Arresters . . .** The flash-back arresters are assembled by dropping a few lengths of wire at a time into the tube and orderly arranging them to form a compact bundle. The last two or three wires should fit snugly and be long enough to extend to the open end of the tube to permit easy disassembly.

After the platinum wire has been welded to the nichrome electrodes, the spiral is formed by closely winding the wire on a drill rod to give a spiral that loosely fits the inside diameter of the tube. It is necessary to space the first four or five turns at the inlet end about one wire diameter to minimize local overheating on rapid combustion, and to space the remaining turns about one-fifth of a wire diam-

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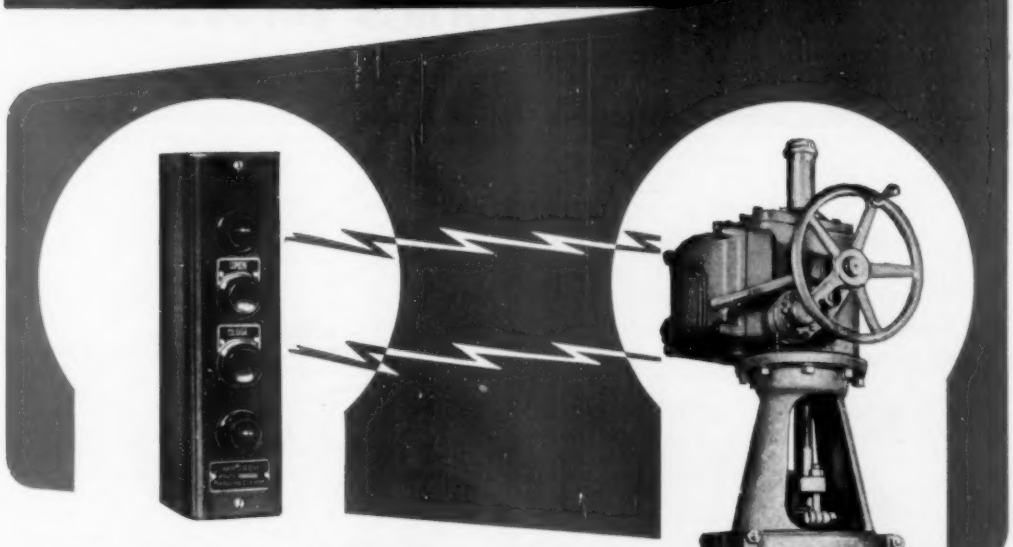

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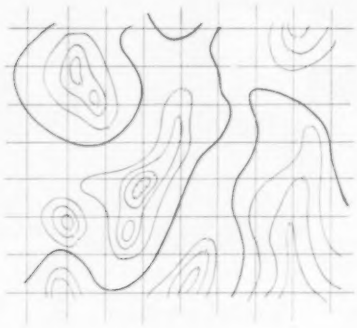

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eter to prevent short circuits. Also, prior to inserting the spiral and electrode assembly into the silica tube, it is important to free the spiral of finger prints with concentrated nitric acid and a water rinse.

**Seals . . .** The removable gas-tight seals between the electrodes and the silica tube are silicone-rubber washers cut from 1 to 2 mm. sheet stock, with cork bores, to fit tightly on the electrodes. Each seal is pressed against the end of the tubing by two small tension springs that are attached to the cooling fin riding loosely on each electrode. One end of each spring is covered with plastic insulating spaghetti to prevent short circuiting the current to the spiral.

**Arrangement of Orsat . . .** Since the efficient operation of the combustion tube requires that all the combustion mixture be burned in a single pass, the arrangement of the pipettes on the Orsat must be changed to permit passage of mercury into the combustion tube as far as the flash-back arresters. The recommended order of the components on the manifold, from left to right, or vise versa if desired, is: Three-way stockcock for entering and purging with oxygen, caustic-filled pipette for absorbing carbon dioxide after combustion, mercury-filled reservoir with leveling bulb, combustion tube coupled to the manifold by a Burrell No. A39-825 U-tube stopcock, burette assembly of the type with water jacket and compensator manometer, (it has been found helpful in rapidly and accurately balancing the pressure in the burette to use dibutyl phthalate in the compensator manometer) pipette for absorbing oxygen, caustic-filled pipette for absorbing carbon dioxide in the sample, and three-way stopcock for entering and purging with the sample.

Additional pipettes may be added to the right of the burette for other operations on the sample such as carbon monoxide or unsaturants removal. With this logical arrangement all operations pertaining to the sample are carried out on the right side of the manifold, and all operations pertaining to combustion are carried out on the left side, in addition to allowing mercury from either the reservoir or the burette force the combustion mixture through the combustion tube in one pass.

The construction of the Burrell "build-up model" Orsat is ideal for this arrangement of the pipettes.

**No supports needed . . .** The combustion tube, when mounted on the stopcock, requires no additional support, but the electrical connection to the electrodes should be made through flexible leads and alligator clips in a manner to prevent moving the electrodes to badly deform the spiral. A source of electric current of approximately 6 amp. at 5 volts for 3 minutes per analysis is required. A suitable transformer or battery and rheostat is satisfactory.

**Combustion procedure . . .** The combustion tube is rinsed with water at the start of a day's run along with the manifold. Excess water is removed by turning on the current to the spiral while a small flow of oxygen is purged through. The tube is cooled and kept full of oxygen until needed. No deviation from the customary procedure for handling the sample is required up to the point of carrying out the combustion.

After the sample and oxygen have

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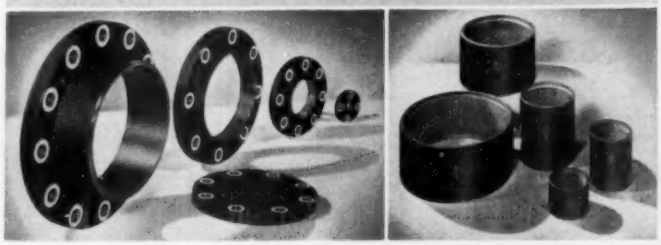

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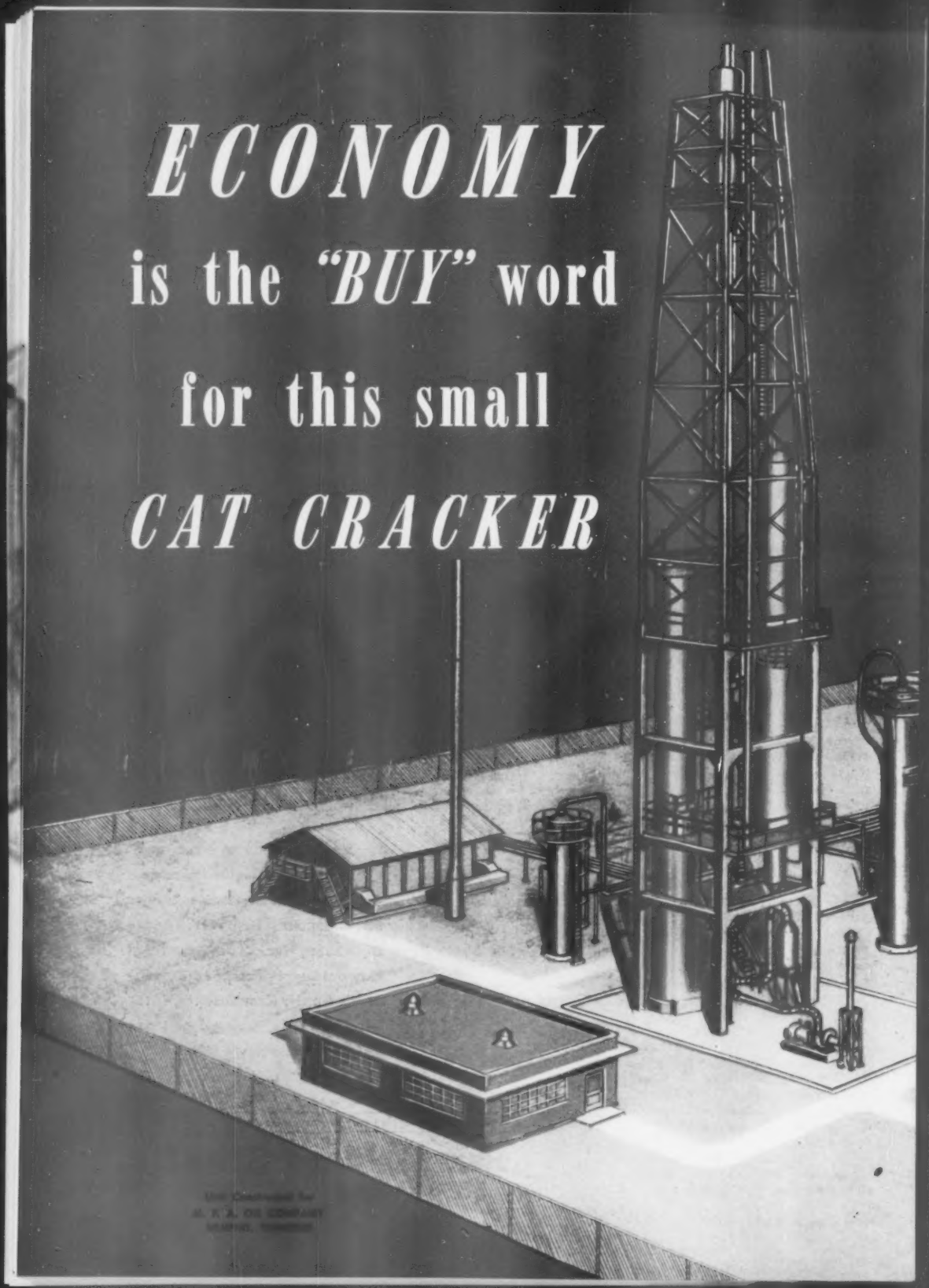
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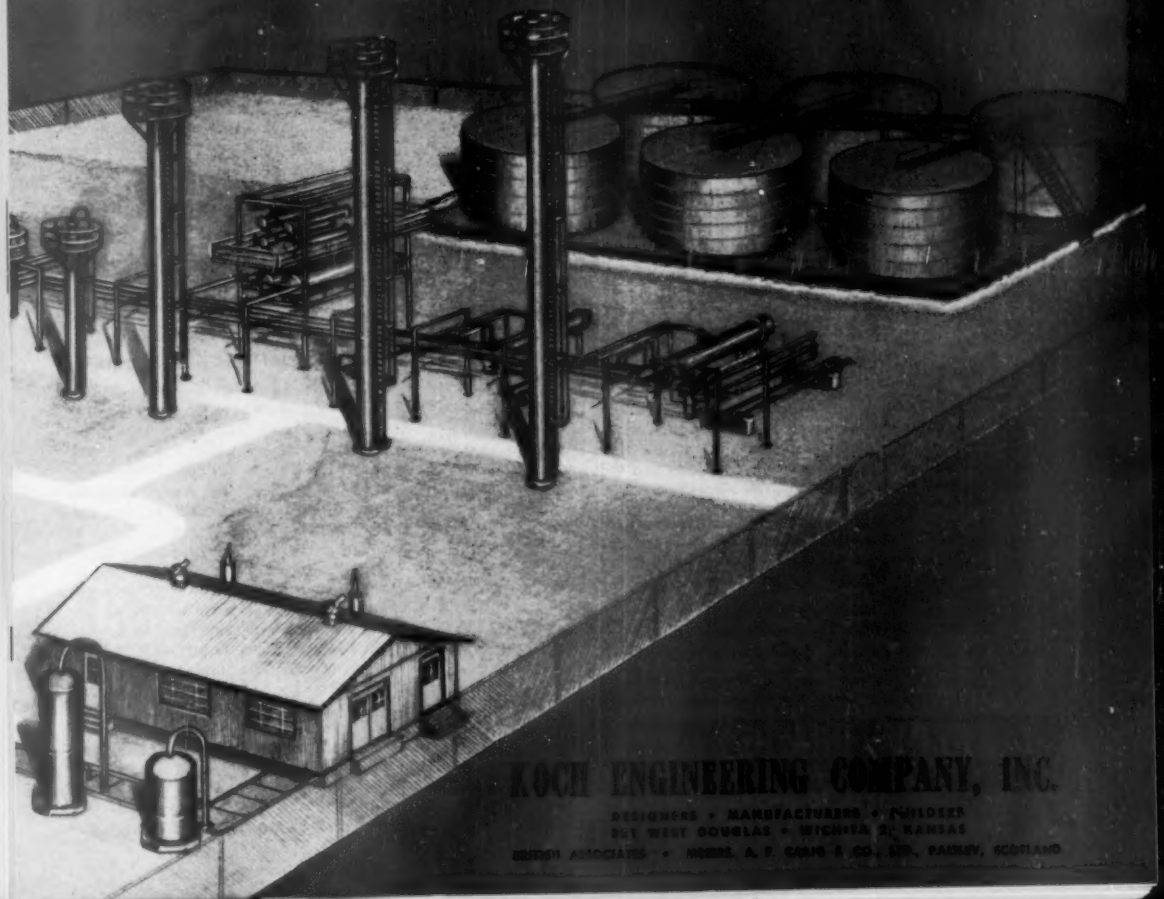

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been measured and mixed, the mercury from the reservoir is raised to the stopcock of the combustion tube and the stopcock to the reservoir closed. All the combustion mixture is now on the burette side of the combustion tube. The stopcock to the combustion tube is now opened and the heating current turned on.

After approximately 30 seconds to allow the spiral to heat, the stopcock to the reservoir is opened and the sample burned at a rate of not over 70 ml. per minute. The inlet end of the spiral will glow more brightly when combustion is taking place. Allow the mercury in the burette to rise to the flash-back arrester. Burn the last traces of sample in the arrester by lowering the mercury a couple of milliliters and again raising it to the arrester.

The current is turned off and the combination products are transferred through the combustion tube to the measuring burette. Allow about 1 minute for the tube to cool before making the final pressure balance and reading of the volume.

**Results . . .** The results from use of the combination tube for analysis of natural gas are shown in the table. Generally one pass through the combustion tube is sufficient, but if the sample contains more than a couple of per cent of hydrocarbons higher than ethane, one to three additional passes may be necessary to sweep the portion adsorbed on the walls of the Orsat through the combustion tube. These passes should be made at less than 30 ml. per minute to prevent excessive cooling of the spiral.

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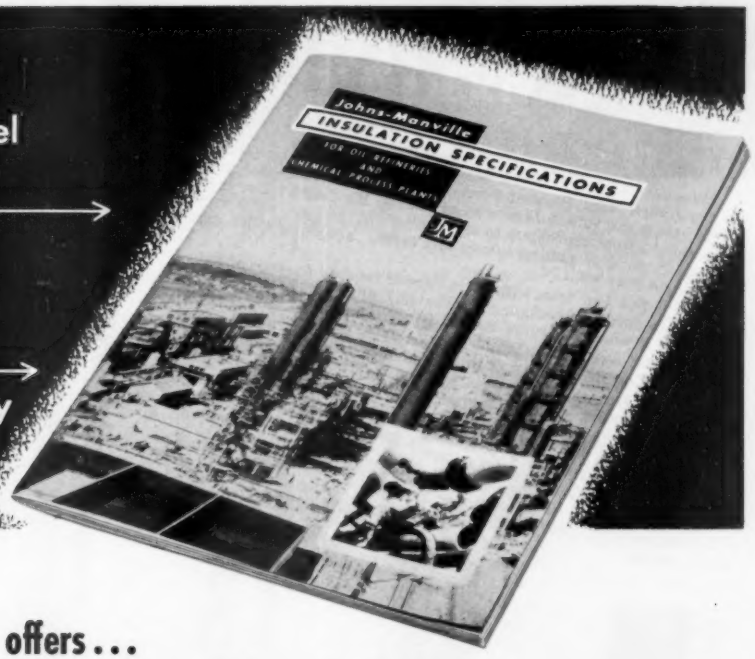


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# Use and Care of Wire Rope—6*

END preparations, seizing, storage, and preliminary preparation for use have been discussed in earlier installments on this subject.

In the process of socketing, the end of the rope is most conveniently held in an upright position in a vise.

At a distance from end of rope equal to length of basket of socket, seize rope securely with wire. Put on two additional seizings back of this guide seizing; these three seizings to be in addition to the original sizing at end of rope.

Remove end seizing and separate strands. This can be conveniently done by using a small piece of pipe as illustrated (1). Cut out hemp core (2) close to the guide seizing, or approximately three-quarters of the length of socket basket. Wipe strands with cloth soaked in gasoline or other grease solvent. Untwist strands with pliers (3), and broom out the wires (4). It is not necessary to straighten each one. Clean wires well for the length they are to be inserted in socket, with kerosine or gasoline, and wipe thoroughly dry.

Dip the wires for a distance not greater than three-quarters of the cleaned length into a solution of one-half commercial muriatic acid and one-half water for from 30 seconds to 1 minute, or until the acid has thoroughly cleaned each wire. Care should be taken that the acid does not come in contact with any other portion of the rope, for if it does wires will be brittle.

Next, dip the wires for about 2 minutes in boiling water containing a small amount of soda (about ½ lb. in 1 gal. of water) to neutralize the acid. Remove rope from soda solution, shake wires free of all liquid and let them dry while still warm. Wires should now be clean and ready for the socket.

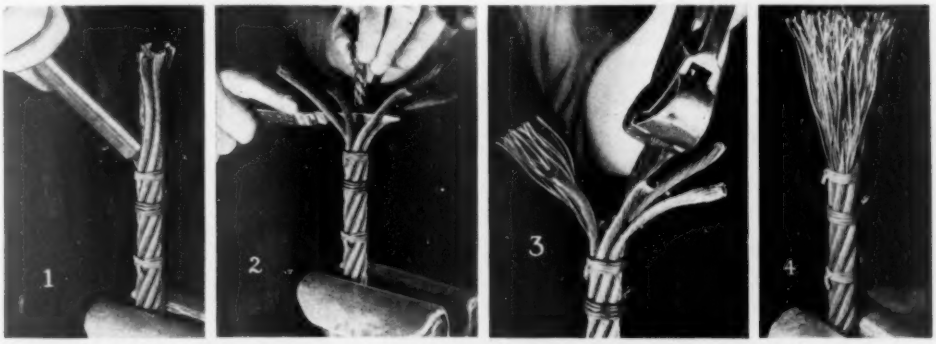
Next, bring wires together and bind with a small wire at extreme end (5), to bring wire within the small diameter of the socket basket. Heat socket slightly to assure even flow of spelter when poured. Place socket over end of wires, and force it down until ends of wires are level with top of basket. Then remove small wire binding at end of wires, allowing them to spread in bowl of socket.

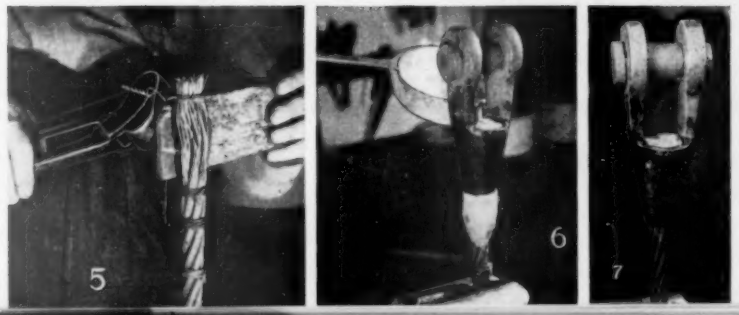
Put some fire clay, putty, or similar material around rope at base of socket to prevent zinc from running out (6). **Hold socket and rope in vertical position, making sure that the socket is in line with the axis of the rope. When holding the socket and rope vertically, see that the rope is not bent to too short a radius.** The effect of too short a radius is to force the wires out of their true relation and develop unequal stresses when the rope is in use.

Pour melted zinc (commonly called spelter) slowly and evenly into basket of socket until it is full (6). Allow zinc to cool while socket and rope are in vertical position. When cool, remove fire clay and all seizings (7).

Use pure spelter, and see that it is in a perfectly fluid condition and free from dross, but not too hot.

*Taken from Bulletin 61, Use and Care of Wire Rope, A. Leschen & Sons Rope Co.




**HOW TO ATTACH SOCKETS... Here are the seven sequential steps to be followed when attaching sockets to wire rope.**

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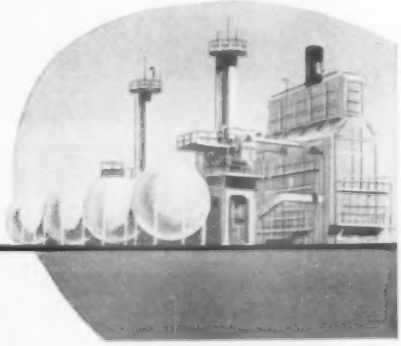

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**by W. L. Nelson**
Technical Editor

# QUESTIONS ON TECHNOLOGY

## Feasibility of Coking

**"Now that fuel oil is so low priced, what is the position of coking? Is coking a profitable operation?" E. G. H.**

The feasibility of coking is almost totally dependent on the value of No. 6 fuel oil and the price obtainable for coke. Thus, if the value of fuel oil is low and a reasonable price can be had for coke, the operation is profitable.

Although coking is usually practiced on relatively light stocks (15°-23° A.P.I.) for the production of large amounts of gas oil (60-80 per cent) and small yields of coke and gasoline, the basic relationship can be most accurately gaged by a consideration of the coking of No. 6 fuel oil as the charge stock. Accordingly, the following discussion is based on the coking of No. 6 fuel oil (8° A.P.I.) into coke, gas, and gasoline. Reasonable yields are (this page, Yields by Coking, July 7, 1952, p. 103):

| | Per bbl. | Weight per cent |
|---|---|---|
| Gasoline | 15.1 gal. | *26.8 |
| Coke | 0.0845 tons | 47.7 |
| Gas | 1.22 M.c.f. | 25.5 |

*36 liquid volume per cent.

The reference indicates even higher yields for an 8° A.P.I. stock (42 liquid volume per cent gasoline) but for an already cracked feed stock, the gasoline yield of 36 per cent was thought to be more satisfactory.

The cost of operating coking plants was explored in the January 19, 1953, issue of this page. Therein, it was found for complete coking (little gas oil produced) that the cost of operation was about 62 cents per barrel. However, the coking of very heavy cracked feed stock would be even more expensive, perhaps 80-85 cents per barrel.

Three cases are investigated in Table 1:

| | Price, No. 6 fuel, dollars per bbl. | Price, gasoline, cents per gal. |
|---|---|---|
| Case 1 | 0.90 | 9 |
| Case 2 | 1.40 | 9 |
| Case 3 | 1.90 | 10 |

This table presents the costs such as (1) value of feed stock and operating cost, and (2) incomes such as value of gas and gasoline. Difference in costs and incomes is amount that must be received for coke.

Inasmuch as 0.0845 ton of coke is obtained per barrel of charge stock, the prices that must be received for coke (Table 1), are about:

$$\text{Case 1} \quad \frac{0.04}{0.0845} = \$0.46/\text{ton}$$

$$\text{Case 2} \quad = \$6.40/\text{ton}$$

$$\text{Case 3} \quad = \$11.12/\text{ton}$$

At current coke and gasoline prices, it seems that coking will be profitable if the price of No. 6 fuel oil is lower than about $1.30 per barrel.

## Molal Average Boiling Point

**"On pages 139-140 of Petroleum Refinery Engineering, the term molal average boiling point is used. Is it intended to indicate an arbitrary concept of some sort?"—R.H.P.**

Boiling points or boiling ranges are ordinarily recorded as liquid-volume per cent distilled versus vapor temperature. The average volumetric boiling point would be obtained by multiplying the temperature by the liquid-volume amount of material that boils at that temperature (or through that temperature range), and then dividing by the total volume (i.e. 100) of material.

The molal average boiling point is exactly analogous to the volumetric average boiling point except that mols or molecules rather than liquid volume is used as the measurement of the amount distilled. Thus, the molal average boiling point is obtained by multiplying the number of mols that boil in each range by the average temperatures of that respective boiling ranges and dividing by the total or 100 mols.

Although the concept of molal average is simple, the computation of it is laborious because the liquid volume per cent (or weight) in each boiling range must be converted into mols by dividing the weight of material in each boiling range by its molecular weight. Accordingly, the relationship between volumetric average boiling point and molal average boiling point has been computed for many mixtures, and consolidated into correlations such as the one shown in Fig. 40, page 141, third edition of Petroleum Refinery Engineering (McGraw-Hill Book Co., Inc., New York, 1949). Such means of obtaining molal average boiling points from the conventional volumetric average boiling point are entirely satisfactory except for those rare, freak materials whose boiling points do not increase smoothly with increases in percentage distilled.

Inasmuch as low-boiling materials have smaller molecular weights than high-boiling ones, it means that distillation curve based on mols (rather than liquid volume) is displaced toward smaller amounts of molecules distilled for a given temperature. Thus, at 50 per cent of liquid distilled, the number of mols distilled will be larger, perhaps 51 to even 75 per cent of the total molecules (depending on the steepness or slope of the distillation curve). Stated conversely, if the boiling point, when half of the liquid volume is distilled is say, 400° F., half of the molecules will have been distilled at some lower temperature than 400° F.

**TABLE 1—REALIZATIONS OF THE COKING OF NO. 6 FUEL OIL INTO GASOLINE, GAS AND COKE FOR THREE MARKET STRUCTURES**
(Dollars per barrel)

| | Case 1 Fuel at 90 cts. | Case 2 Fuel at $1.40 | Case 3 Fuel at $1.90 |
|---|---|---|---|
| Costs: | | | |
| A.S.T.M. No. 6 fuel | $0.90 | $1.40 | $1.90 |
| Operation | 0.80 | 0.80 | 0.85 |
| Total | $1.70 | $2.20 | $2.75 |
| Incomes: | | | |
| Gasoline | $1.36 | $1.36 | $1.51 |
| Gas | 0.30 | 0.30 | 0.30 |
| Total | $1.66 | $1.66 | $1.81 |
| Must receive for coke | $0.04 | $0.54 | $0.94 |

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# EQUIPMENT MEN . . . in the News

## Metal Goods Holds General Sales Conference

**In attendance at the Metal Goods Corp. general sales conference at Hot Springs, Ark., were: front row: William E. Meni, controller; Harris T. Gregg, vice president; George P. Baumunk, vice president; Sam D. Hodgdon, vice president; Robert E. Grote, Sr., president, Robert E. Grote, Jr., vice president and director of sales; Landon B. Atkins, secretary; Howard S. Reasor, senior vice president, and Walter R. Mayne. Back row: Scott J. Harrison, branch manager; Carl T. Wedemeyer, Frank Hogan, and Neal Dehn, branch managers; John H. Harwood, director of personnel; Nels Hower, branch manager; Thomas G. Rankin, manager, industrial products; James J. Langen, advertising manager; Raymond C. Krueger, manager, manufacturing division, and Donald A. FitzRoy, assistant manager, industrial products.**

A general sales conference was recently held at the Arlington Hotel in Hot Springs, Ark., by Metal Goods Corp. More than 100 sales and management men attended. Company policies and plans for the future were discussed.

In the business sessions Robert E. Grote, Jr., director of sales, Metal Goods, presided over the meetings. Robert E. Grote, Sr., president, gave a welcoming address and stressed the policies and objectives of the company. One of the highlights of the meeting was the main after-dinner speech given by H. B. Sharer, sales-training specialist of U. S. Rubber Co.

Other speakers at this meeting were: Harris T. Gregg, vice president; L. B. Atkins, secretary; Howard S. Reasor, senior vice president; Sam D. Hodgdon, vice president; George P. Baumunk, vice president; Tom G. Rankin, manager, industrial products; Donald A. FitzRoy, assistant manager, industrial products; Nels Hower, branch manager; James J. Langen, advertising manager, and John H. Harwood, director of personnel.

## Stewart & Stevenson to Distribute Climax Engines

With the appointment as Texas distributor for Climax Blue Streak engines, Stewart & Stevenson Services has marked another milestone in its steady growth as one of the largest sales and service organizations in Texas for industrial power users. The appointment was effective January 1.

Addition of the Climax Blue Streak line of engines does not conflict with the General Motors, Chrysler Industrial, or any other engines now sold and serviced by Stewart & Stevenson, according to Joe Manning, vice president and general manager of the company. The addition of the new line completes the range of power requirements for Texas industries.

Climax Blue Streak engines will be sold and serviced by Stewart & Stevenson branches throughout Texas, and the line of Climax engines will make available to the natural-gas or butane user a complete range of engines up to 600 hp.

## Vickers Opens District Warehouse at Odessa, Tex.

O. G. Houser, Vickers, Inc., El Segundo, Calif., has announced the opening of a warehouse and sales and service headquarters at Odessa, Tex., which is to be district headquarters to serve the Permian basin area of West Texas, and New Mexico.

George W. Morte has been named district manager in charge at Odessa. Morte has been an employe of Vickers for 12 years. He is being transferred from California where he has been West Coast service manager.

## Four Advancements Named By Rockwell Manufacturing

L. A. Dixon, Jr., vice president, Rockwell Manufacturing Co.'s meter and valve division, has announced the appointments of Paul C. Kreuch as assistant to vice president in charge of sales; Courtney C. Shenkle as assistant to vice president in charge of manufacturing; C. C. Moore as central regional manager of sales, and W. S. Andrews as district manager of the Pittsburgh district.

Kreuch came to Rockwell in 1930, and spent 4 years as a sales engineer in the San Francisco and Tulsa areas, and was then promoted to district manager of the Chicago area. For the past

P. C. KREUCH

C. C. SHENKLE

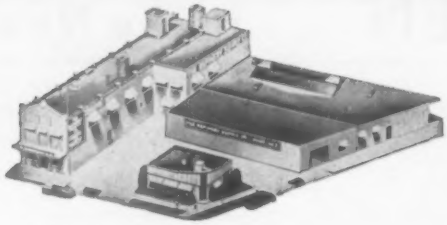
year he has been regional sales manager of the central region which extends from Pittsburgh to the Midwest. Along with his new duties Kreuch will continue to supervise sales in the Chicago area, with headquarters in Pittsburgh.

C. C. MOORE

W. S. ANDREWS

Shenkle was formerly assistant to the president of Pittsburgh-DuBois Co. When this company became a division of Rockwell in 1947 he was named assistant to the general manager and finally became general manager. In 1950 he was transferred to the Freeport, Ill., division, and more recently to the Macnick division.

Moore joined Rockwell in 1930 as head of the now-defunct Meter Parts Co. Later he became district manager of the company's Atlantic office, and



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more recently district manager of the company's Pittsburgh territory.

Andrews was district manager of the New York area before assuming his present position. He was formerly affiliated with Beaver Pipe Tools, Inc., of Warren, Ohio, and joined the Nordstrom Valve division of Rockwell as a salesman in 1932.

## Republic Rubber Forms New Southwest District

W. T. WILLEY

The formation of a new Southwest district of the Republic Rubber Division, Lee Rubber & Tire Corp., has been announced by G. L. Smith, Republic's sales manager. W. T. Willey, formerly field representative, has been appointed district manager with headquarters in Tulsa.

Other members of the new district sales organization who will be responsible for the sale and service of Republic's line of belting, hose, and packing are: R. J. Cravens, who will headquarter in Dallas; D. L. Cushing, Houston, and R. E. McQuiston, Midland, Tex.

## Getten Named to Head Pioneer Sales District

F. D. GETTEN

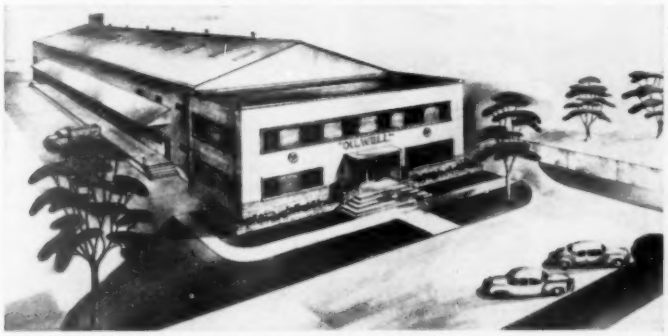
Fred D. Getten has been named by the mechanical rubber-goods division of Pioneer Rubber Mills as manager of the southwestern district, according to an announcement by J. E. (Gene) Barton, territory representative in the Southwest sales division.

Getten, whose territory will include the Texas Panhandle and western Arkansas, will make his headquarters in Oklahoma City. Until this appointment, Getten has been actively engaged in oil field representation of mechanical equipment.

## Lane-Wells Establishes New Louisiana Station

Lane-Wells Co. has added another service point to its Gulf Coast network. This new truck station is at Ruston, La., which brings the number of service locations in the Ark-La-Tex district to six. This makes a total of 73 branches for Lane-Wells, with 8

## Oilwell to Build Oil Field Supply Center at Houston



Oil Well Supply's proposed store building and warehouse at Houston.

Fred F. Murray, president of the Oil Well Supply Division of U. S. Steel Corp., Houston, recently announced plans for a major new oil-field supply center at Houston to serve the extensive Gulf Coast region. The new supply and service unit will serve principally as Oilwell's district warehouse in Houston, supplanting a smaller unit.

The new Oilwell facility will be built at 6100 Clinton Drive. Construction is scheduled to begin in early March, and it is expected to be ready for operation in about 6 months, Murray said.

The warehouse will be one of the largest of Oilwell's numerous warehouses over the United States and Canada. It will serve three districts in its Gulf Coast area, whose headquarters are in Houston, backing up the stocks of the division's field stores along the coastal region from Mission, Tex., to Brookhaven, Miss. The store will serve Houston and the surrounding area.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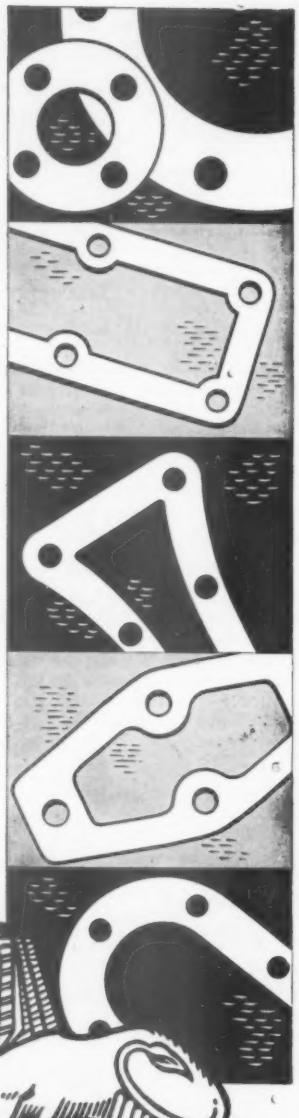

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The Ruston station was established better to serve the expanding operations in the Ruston and Delhi area. Joe McLendon, who has been with Lane-Wells since 1941, and previously at Longview, Tex., is operator-in-charge of this station.

## Three Sales Appointments Named by Alten Foundry

R. L. LEDEKER

Warren M. Benson, vice president and sales manager of Alten Foundry & Machine Works, Inc., Lancaster, Ohio, has announced the appointment of three new oil-field sales representatives. Robert L. Ledeker has been named Alten representative in Kansas. Ralph F. Griffin has been assigned to the tristate territory including Indiana, Illinois, and western Kentucky. C. W. (Clem) Freeman now represents Alten in the State of Oklahoma.

R. F. GRIFFIN

C. W. FREEMAN

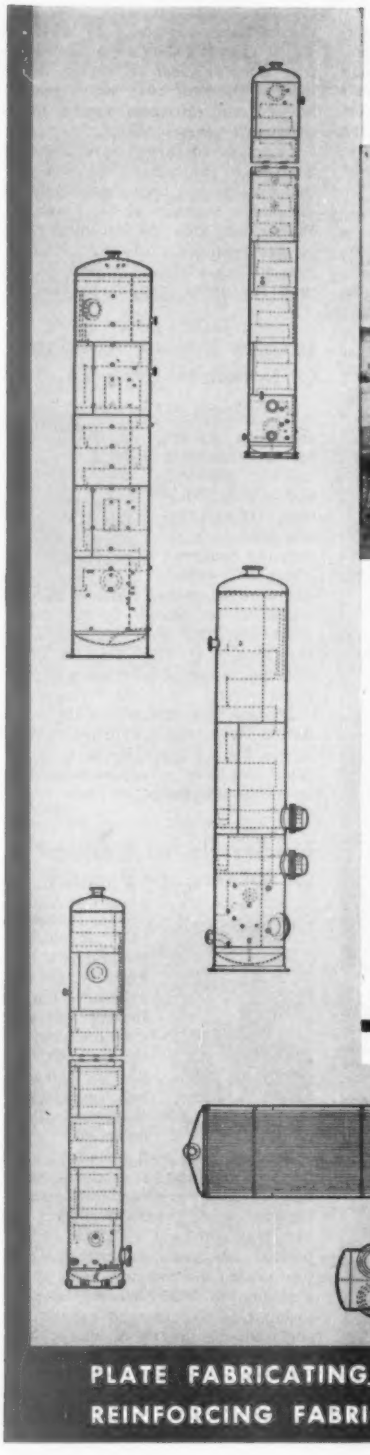
Ledeker previously covered the tristate area of Indiana, Illinois, and western Kentucky for Alten during 1950 and 1951. His headquarters will be in Hutchinson, Kans.

Griffin was formerly superintendent of eastern leases for the Griffin Producing Co. of Tulsa. He recently completed the sales training course at Lancaster, and has established temporary headquarters at Princeton, Ind.

Freeman, a former supply-company store manager, has completed the Alten sales indoctrination course, and has established offices at Duncan, Okla.

## Continental Equipment Co. Names Executive Changes

According to an announcement made by Arthur M. Capper, president, Continental Equipment Co., John D. Hantz



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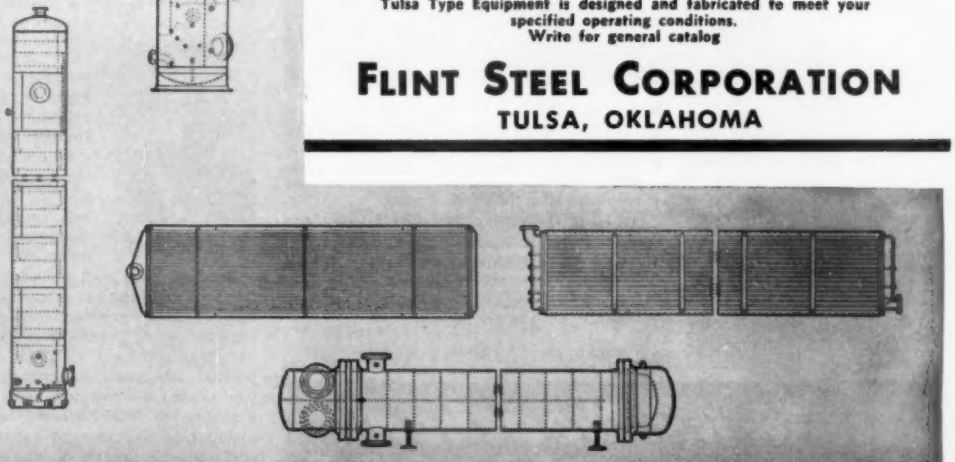

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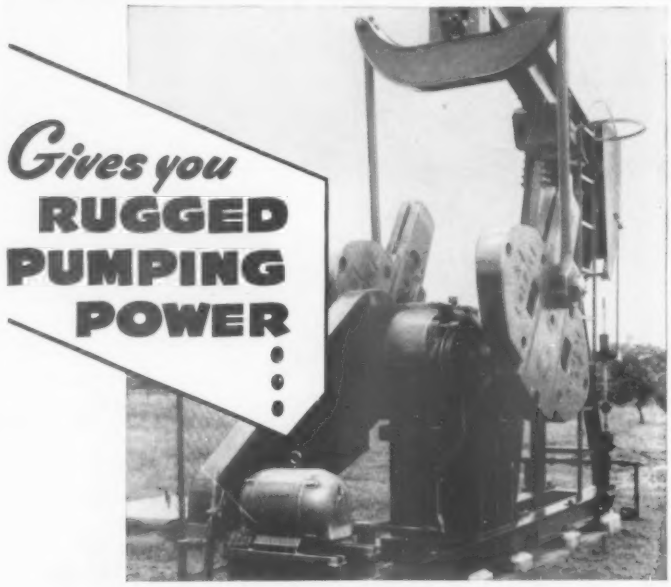
has been named executive vice president, and Glenn G. Buzza and Charles A. Dally, vice presidents of the company. Continental, with plant and offices in Corapolis, Pa., are manufacturers of heavy industrial-type butterfly valves.

## West Is Made General Sales Engineer for Dowell

M. L. Stirling, general sales manager for Dowell Incorporated, has announced the promotion of L. E. West to position of general sales engineer. H. B. Green will succeed West at Houston. West will be located at the company's headquarters in Tulsa, and his responsibilities will include customer relationship and sales promotion in all Dowell areas where the company offers its chemical maintenance service except the Atlantic coast territory which will continue to be under L. B. Wilson, operating out of Dowell's New York office.

West attended Kansas University and Cornell, and holds a B.S. degree in chemical engineering from Cornell. He joined Dowell early in 1943 as a development engineer at Chicago. In January 1945 he moved to Dowell's Philadelphia office where he served as district development engineer, and as district sales engineer. In 1945 he joined Dowell's Houston office as district sales engineer in charge of industrial chemical sales, which position he held until his recent transfer to the company's general offices.

Green joined Dowell as an industrial engineer in September 1944, and since that time he has been successively development engineer at St. Louis and Wilmington, Del. In December 1949 he was promoted to district sales engineer at Philadelphia, a position he held until his recent transfer to Houston.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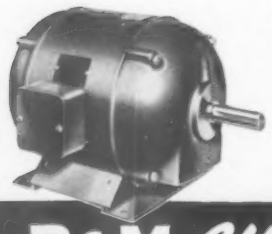

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## Langton Is Made Associate Of Darwin H. Clark Co.

To provide greater service facilities for its clients in the oil, chemical, and mining industries, Arthur Langton, prominent advertising executive, editor and writer, has become associated as an account executive and technical writer with Darwin H. Clark Co., one of the principal industrial advertising agencies in the West.

Langton was formerly editor of the Baroid News, and advertising manager of the Baroid Sales Division of National Lead Co., a concern with which he was associated for 16 years.

## Bradley Elected President Of Builders Iron Foundry

E. H. BRADLEY

At a meeting of the directors of Builders Iron Foundry in early February, Earl H. Bradley was elected president to succeed Henry S. Chafee. Chafee will remain as treasurer of the company.

Bradley came with Builders in December 1934, and has served in capacities of shop superintendent, general superintendent, works manager, and vice president, and in 1949 was appointed executive vice president. Before joining the company, Bradley was a partner in Miner-Bradley Manufacturing Co., and also an experimental engineer with Brown & Sharpe Manufacturing Co.

Chafee joined Builders in 1909 and was elected secretary in 1913, assistant treasurer in 1917, treasurer in 1930, and president in 1944.

# Pipe-Line Construction

PIPE-LINE activity as reported below by The Oil and Gas Journal is compiled from information received from pipe-line companies and contracting firms.

These projects include those planned, proposed, under way, and contracted. Uncontracted projects are indicated by a • preceding the company name.

### Crude-Oil Pipe Lines

• **California-Oregon Pipe Line System**—103 miles, 6-in., proposed, Crescent City, Calif., to Medford, Oregon.

• **Cities Service Pipe Line Co.**—64 miles, 18-in., under way, Sour Lake, Tex., to Lake Charles, La. Associated Pipe Line, contractors. Completion date April 1953.

**Cooperative Refinery Association.**—48 miles 6-in., under way, Phillipsburg, Kans., to Holdredge, Neb.

• **R. A. Goodall.**—45 miles, 6-in., planned, Little Beaver to Merino, Colo. (To connect with Sterling system).

• **Gulf Oil Co.**—22 miles, 8-in., planned, Portilla field, Texas, to Corpus Christi.

• **Gulf Refining Co.**—55 miles, 10-in., planned, Bay Marchand to Plaquemines, La.

• **Humble Pipe Line Co.**—71 miles, 16-18-in., planned, East Texas to Louisiana-Texas border. (30 miles of 16-in., and 41 miles of 18-in.) Completion date 10-53.

Under way, Hawkins field, Woods County, Texas, to Longview.

Start 7-1, Longview to Louisiana border.

• **Interstate Oil Pipe Line Co.**—22 miles, 18-in., planned, Texas to Shreveport, La.

137.6 miles, 22-in., planned, Shreveport to Baton Rouge.

**Interstate Oil Pipe Line Co.**—68 miles, 16-in., under way, Raceland to Anchorage, La.

Under way, Raceland to Plaquemine, La. L. E. Farley, Inc. 6-15-53.

Plaquemine to Anchorage, La.

**Lakehead Pipe Line Co.**—635 miles, 30-in., under way, Superior, Wis., to Sarnia, Ontario, Canada.

Under way, Michigan-Wisconsin State line to near Crystal Falls, Mich. Anderson Bros. 10-53.

Under way, Crystal Falls, Mich., to Cooks, Mich. Anderson Bros. 10-53.

**Mackinac Pipe Line Co., Inc.**—97 miles, 30-in., start 5-1, Cooks to St. Ignace, Mich. Midwestern Constructors, Inc.

• **Magnolia Pipe Line Co.**—29 miles, 8-in., planned, Midland County, Texas area.

47 miles, 4-6-8-in., planned, Nolley field, Andrews County to Magutex field, West Texas.

• **Pasotex Pipe Line Co.**—146 miles, 10-in., planned, Snyder to Wink, Tex.

• **Phillips Pipe Line Co.**—45 miles, 12-in., planned, Rancho system to Sweeny, Tex. 6-53.

• **Platte Pipe Line Co.**—93 miles, 12-14-in., planned, Chatham station near Worland, Wyo., to Oregon basin, and Byron field. R. H. Fulton Co. Completion date 6-53.

Chatham, Wyo., to Oregon basin. R. H. Fulton Co.

Oregon basin to Byron-Garland field. R. H. Fulton Co.

• **Progress Pacific Pipeline Co.**—1,100 miles, 24-in., planned, Odessa, Tex., to Los Angeles Harbor, Calif.

• **Pure Transportation Co.**—45 miles, 8-in., planned, Kimball to Gurley, Neb.

• **Roosevelt Oil & Refining Corp.**—22 miles, 4 and 6-in., planned St. Helens to Norwich, Mich.

• **Service Pipe Line Co.**—185 miles, 16-in., planned, Bowie, Tex., to Drumright, Okla.

30 miles, 6-in., Knox and Haskell counties, Texas.

29 miles, 4-6-8-in., proposed, Natrona County, Wyoming.

170 miles, 12-in., proposed, Tioga to Williston, N. D.

41 miles, 4-6-8-in., planned, Williams and Mountrail counties, North Dakota.

• **Texas-New Mexico Pipe Line Co.**—48 miles, 8-in., planned, from Lovington, N. M.

**Texas Pipe Line Co.**—34 miles, 6-in., under way, Sour Lake to Port Arthur, Tex. Houston Contracting.

• **West Coast Pipeline Co.**—960 miles, 20-22-in., planned, Wink, Tex., to Norwalk, Calif.

### Products Pipe Lines

**H. W. Bass & Sons., Inc.**—152 miles, 4-6-in., proposed, Duval and Live Oak counties, Texas, to Corpus Christi, Tex.

• **Bell Oil & Gas Co.**—150 miles, 6-8-in., planned, Ardmore to Drumright, Okla. Completion date 6-1-53.

**Buckeye Pipe Line Co.**—370 miles, 10-14-16-in., under way, Linden, N. J., via Allentown, Pa., to Auburn, Syracuse, Waterloo, and Rochester, N. Y.

Contracted, Allentown, Pa., to Auburn, N. Y. Completion date 10-53.

Contracted, Auburn to Syracuse, N. Y. Completion date 10-53.

Contracted, Syracuse to Caledonia, N. Y. 10-53.

• **Coastal Products Pipe Line Co.**—260 miles, 20-in., proposed, Houston to Baton Rouge.

• **Continental Pipe Line Co.**—(Yellowstone Line)—600 miles, 8-in., planned, Billings, Mont., to Spokane, Wash.

• **Harbor Products Systems**—86 miles, 16-in., planned, Woodbury Junction, Philadelphia to Trembley Point, N. J. (Joint ownership of Sinclair Pipe Line Co., Gulf Oil Corp., and Texas Co.)

**Indiana Farm Bureau Cooperative Association, Inc.**—180 miles, 8-in., under way, Mt. Vernon to Indianapolis, Ind. R. B. Potashnick, contractor.

70 miles, 4-in., under way, Indianapolis to Peru, Ind. R. B. Potashnick, contractor.

**Inland Empire Pipe Line Co.**—504 miles, 10-in., proposed, Billings, Mont., to Spokane, Wash.

• **Kaneb** Pipe Line Co.—236 miles, 8-in., planned, Wichita and Potwin, Kans., to Fairmont, Neb.

• **Phillips Petroleum Co.**—54 miles, 6-in., planned, Goldsmith to Borger, Tex.

52 miles, 10-in., planned, Shell's Brookshire system to Sweeny, Tex. 5-53.

• **Plantation Pipe Line Co.**—82 miles, 14-in., planned, Charlotte to Greensboro, N. C.

**Salt Lake Pipe Line Co.**—140 miles, 8-in., Paseo to Spokane, Wash. Completion date 6-53.

**Standard Oil Co. (Ind.).**—316 miles, 12-in., under way, Sugar Creek refinery to Dubuque, Iowa.

Under way, Polo, Mo., to Unionville, Mo. Sheehan Construction Co.

Planned, Mandan, N. D., to Moorhead, Minn.

• **Standard Oil Co. (Ind.).**—243 miles, 10-12-in., proposed, Whiting, Ind., to River Rouge, Mich.

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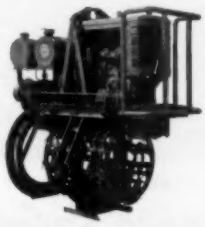
Designed to operate in all types of terrain, CROSE Line travelling cleaning and priming machines are equipped with dual multi-speed transmissions providing greater flexibility of control. Interchangeable cleaning and priming assemblies permit each model to process a wide range of pipe sizes. Model M handles 3" to 14" pipe, Model K handles 16" to 26" pipe and Model R handles 30" to 31" pipe.



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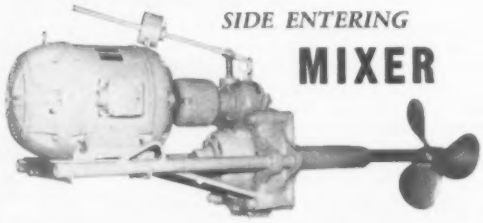

The SHORTSTIR Mixer, installed in crude oil pipe line storage tanks, pays for itself by preventing sediment accumulation. It eliminates costly tank clean-out . . . down time for clean-outs . . . loss of marketable oil . . . makes chemical treating unnecessary in most cases or improves efficiency of treatment where required . . . and maintains maximum storage capacity. Installation usually costs less than one clean-out and yields appreciable future savings.

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West of the Rockies, it's Ampco Burbank Plant, Burbank, Calif. • In Canada — Safety Supply Co., Toronto, Ont.

**Sun Pipe Line Co.**—110 miles, 8-in., under way, Fostoria to Hudson, Ohio.

• **Texas Pipe Line Co.** (Evangeline Products Systems)—196 miles, 16-in., under way, Port Arthur, Tex., to Baton Rouge, La. Panama-Williams Co. Completion date 7-53.

**Texas Pipe Line Co.**—29 miles, under way, Fuller Ranch gasoline plant to Basin Pipe Line System, West Texas. Holder Const. Co.

• **United States Pipe Line Co.**—1,799 miles, 22-26-in., proposed, Beaumont, Tex., to Newark, N. J.

Beaumont, Tex., to Memphis, Tenn.
Memphis, Tenn., to Louisville, Ky.
Louisville, Ky., to Newark, N. J.
Laterals to Paducah and Lexington, Ky.

• **Wolverine Pipe Line System**—200 miles, 14-in., planned, Chicago to Toledo and Detroit. (Joint ownership of Shell, Texas, and Cities Service). Completion date 1-54.

## Natural-Gas Pipe Lines

• **Allied Gas Co.**—24 miles, 6⅝-in., proposed, McLean to Champaign County, Illinois.

• **Arkansas-Missouri Power Co.**—140 miles, 2 to 10-in., planned, St. Francis River, Clay County, Arkansas, to near Campbell, Mo.

• **Associated Natural Gas Co.**—88 miles, Missouri.

• **Carolina Natural Gas Corp.**—185 miles, 2-12-in., proposed, lateral lines off Transcontinental in North and South Carolina.

• **Chattahoochee Natural Gas Co.**—70 miles, proposed, Floyd County, Georgia, to Dalton, Ga.

• **Chicago District Pipe Line Co.**—35 miles, 24-30-in., proposed, Chicago area.

**Cities Service Gas Co.**—21 miles, 26-in., planned, Franklin and Anderson counties, Kansas.

15 miles, 20-in., Craig County, Oklahoma, to Lawrence County, Missouri.

• **Coast Counties Gas & Electric Co.**—40 miles, 3, 4, and 8-in., planned. Coast and Valley region, California.

**Colorado Interstate Gas Co.**—250 miles, 20-in., under way, Kit Carson, Colo., to Amarillo, Tex. R. H. Fulton & Co., contractor.

Pueblo County to Fowler, Colo.

• **Colorado Interstate Gas Co.**—365 miles, 22-in., proposed, Green River, Wyo., to Denver, Colo.

• **Cumberland and Allegheny Gas Co.**—31 miles, 12-in., proposed, Garrett County, Md., to Keyser, W. Va.

• **East Tennessee Natural Gas Co.**—158 miles, 16-in., planned, Knoxville to Kingsport, Tenn. (58 miles of laterals.) 11-53.

• **El Paso Natural Gas Co.**—1,778 miles, proposed, Permian basin, New Mexico, Texas, and Colorado.

• **Glacier Gas Co.**—285 miles, 20-in., proposed, Kalispell, Mont., to Spokane, Wash.

120 miles, 16-in., proposed, Spokane to Hanford, Wash.

91 miles, 8⅝-in., proposed, Spokane to Lewiston, Idaho.

130 miles, 12¾-in., proposed, Spokane to International boundary at Trail, British Columbia.

• **Gulf Interstate Gas Co.**—860 miles, 30-in., proposed, Acadia Parish, La., to Boyd County, Ky.

329 miles, 12 to 24-in., proposed. Laterals off Acadia Parish, Louisiana, to Boyd County, Kentucky, line.

• **Home Gas Co.**—32 miles, 12-in., planned. Breesport to Union Center, N. Y.

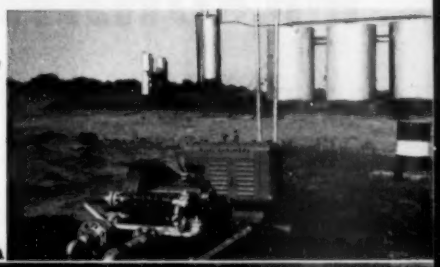
17 miles, 12-in., proposed, loops from Hansock to Sanford, N. M.

46 miles, 12-in., under way, Tioga and Broome counties, New York. H. L. Gentry Const.

22 miles, 12-16-in., under way, Binghampton, N. Y.

# Allis-Chalmers

## *Built to last longer . . . Cost less to repair*



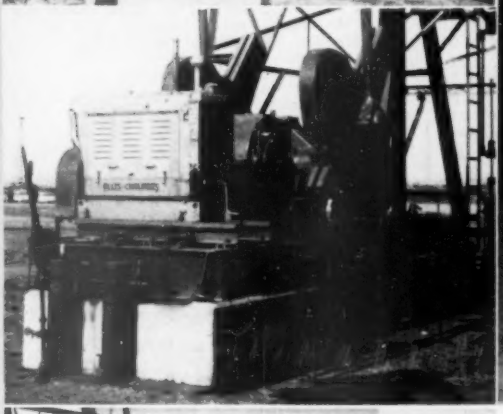
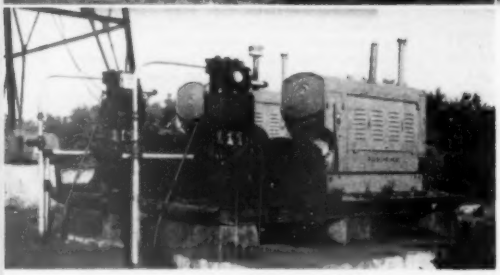


Photo courtesy of Deep Rock Oil Corporation



EIGHT YEARS of continuous *24 hours* a day service before requiring an overhaul. A tribute to *good lubricants* and a good engine.

This Allis-Chalmers W-201 Engine, on Deep Rock Oil Corporation's Blackburn B-#1 at Fairfield, Illinois, ran more than 70,000 hours before overhaul.

COSTS LESS to repair. After this long period of service, the crankshaft and bearings were still in good condition.

Compare Allis-Chalmers repair parts cost with those of other engines of equivalent size. You'll be surprised at the lower cost.

1. Model B Engine on Gaso pump at Elmore City.
2. Model W-201 pumping from 3000' at Wewoka.
3. Model U-318 on 4100' well at Holdenville.
4. Two model E-563 engines on Kobe pumps. 6000' production at Oklahoma City.

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# Before you buy anybody's MICROWAVE SYSTEM

## *Consider these 5 facts!*

**1. Who is the manufacturer?**

When you specify RCA, the answer is easy. Because RCA is the world's greatest name in radio, television, and related activities. RCA has pioneered in high-frequency radio communications and really knows microwave from start to finish.

**2. What has he actually done in the microwave field?**

Again, RCA has rolled up an impressive record. Installed and operating are more than 19,000 channel miles of RCA microwave systems, for pipelines, power utilities, turnpikes, and government agencies. One system is over 1000 miles long, extends from New York to Washington and Pittsburgh. And after three years' continuous experience, expansion is being planned . . . proof enough of *outstanding RCA performance.*

**3. Is he equipped to install microwave?**

Again, with RCA, the answer is "yes." RCA will handle your installation for you . . . will even furnish you with a detailed aerial survey of the microwave route.

**4. Is he equipped to maintain microwave?**

Again, RCA is out in front, with a nationwide service organization geared to handle your microwave maintenance on a 24-hour basis. It's the *RCA Service Company*—already well known for its service to industry on other types of electronic equipment. It's available to you when *you* specify RCA.

**5. Is the equipment designed with an eye to the future?**

Yes . . . if it's RCA equipment.

For instance—consider the matter of adding additional voice and signal channels. Thanks to RCA's "eye to the future" design, you can add or drop channels at any station with a minimum of cost . . . a minimum of equipment.

**Why settle for less than RCA MICROWAVE?**

When you start talking about microwave, you're talking about *money*. So isn't it just good sense to be sure you invest in the best? With RCA, you're dealing with the leading name in radio . . . with men who *know* microwave. *So specify RCA—and be sure.*

**You get these 7 plus features with RCA Microwave**

1. Uses conventional tubes throughout.
2. Easy to tune. Has built-in metering.
3. Handles large number of single sideband frequency division channels without excessive cross-talk.
4. Flexible. Any or all voice or control channels can be picked up or dropped at any station, repeater or terminal.
5. Service channel with signaling available at each repeater and terminal station.
6. Vertical space, provides ready access both front and rear.
7. Designed, built, and backed up, by RCA . . . world leader in electronics.

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• **Hope Natural Gas Co.**—33 miles, 8-10-12-in., planned, Wyoming County, West Virginia, south to Buchanan County, Virginia.

**Houston Pipe Line Co.**—40 miles, 16-in., under way, Edna to Tom O'Connor gas field. Houston Contracting Co. 4-53.

• **Interstate Power Co.**—26 miles, 8-in., proposed, from Nat. Gas P. L. Co. America line near Hooppole, Ill., to Clinton, Ia.

**Iowa-Illinois Gas & Electric Co.**—41 miles, 10-in., planned, Washington County to Cedar Rapids, Iowa.

• **Kansas-Nebraska Natural Gas Co., Inc.**—179 miles, planned, Kansas and Nebraska.

54 miles, 4-6-in., planned, Neligh to Hartington, Neb. Completion date 1953.

42 miles, 4-6-in., planned, Neligh to O'Neil, Neb. 9-53.

196 miles, planned, to serve Wisner, Pilger, and Stanton, Neb.

**Kansas Nebraska Natural Gas Co.**—70 miles, 6-8-in., under way, Nebraska City to Denver-Julesburg basin, Colo.

• **Lone Star Gas Co.**—100 miles, proposed, storage fields to the Dallas-Fort Worth area.

35 miles, 12-in., proposed, southeastern Schleicher County.

• **Manufacturers Gas Light & Heat Co.**—40 miles, proposed, Allegheny, Washington, and Beaver counties, Pennsylvania.

213 miles, 3 to 26-in., proposed, various points on system in Pennsylvania, West Virginia, and Ohio.

• **Michigan Gas Storage Co.**—30 miles, 26-in., planned, Lainsburg Junction north. 7-53.

• **Midsouth Gas Co.**—191 miles, planned, Helena to Palestine, Ark.

• **Mississippi River Fuel Corp.**—109 miles, 10-18-in., planned, laterals in Woodlawn and Waskom gas fields, Texas.

**Missouri Central Gas Co.**—25 miles, 6-in., contracted, Moberly to Macon, Mo. L. R. Young Const. Co.

• **Missouri Public Service Co.**—136 miles, 8-10-in., proposed, New Franklin to Trenton, Mo.

• **Montana Power Co.**—52 miles, 16-in., planned, Canada - Montana border to Cut Bank, Mont.

• **Morganfield Natural Gas Co.**—31 miles, 4-6-in., planned, through Sturgis, Providence, Clay, Diamond, Wheatcroft, and Sullivan, Ky.

• **Natural Gas Producers Inc.**—100 miles, 12-in., planned, Yenter pool to Denver, Colo.

• **Nevada Natural Gas Pipe Line Co.**—114 miles, 12¾-in., proposed, Topock, Ariz., to Las Vegas, Nev.

• **New River Gas Co.**—50 miles, planned, Summers to Monroe counties, West Virginia, to Narrows and Dublin, W. Va.

• **New York State Electric and Gas Co.**—59 miles, 8-10-24-in., proposed, Oneonta and Norwich to DeRuyter, N. Y.

**New York State Natural Gas Corp.**—104 miles, 14, 16, 20-in., under way, looping on Westmoreland, Armstrong, and Tioga counties, Pennsylvania. (Includes 17 miles, 16-in., in Potter County, Pennsylvania, and 21 miles 14-in., replacement in Line No. 507, New York.)

Colesburg Junction to Sabinsville, Pa. (begin at completion of Angelica job), Williams-Austin. Howard Bauer, superintendent.

21 miles, Columbiana and Stark counties, Ohio.

• **New York State Natural Gas Co.**—75 miles, 20-in., proposed, Cameron County to Armstrong County, Pennsylvania.

58 miles, 14 and 20-in., planned, New York State line.

Sabinsville to Boom station.

Skaneateles to Onondaga, N. Y.

Ithaca to Dryden, N. Y.

**Niagara Mohawk Power Corp.**—55 miles,

10-in., begin 4-1-53, Watertown to Syracuse, New York. Williams-Austin Co.

• **Northern Indiana Fuel & Light Co.**—33 miles, 8-in., proposed, Edgerton to Auburn, Ind.

• **Northern Natural Gas Co.**—580 miles, proposed, Kansas, Texas, Oklahoma, and Nebraska loops.

210 miles, 26-in., planned, five loops in Texas-Oklahoma area, two in Kansas, and two in Nebraska.

400 miles, 24-in., proposed, Emerson, Manitoba south to Red River Valley through Fergus Falls on to St. Paul, Minn.

102 miles, planned, extension.

**Northern Natural Gas Co.**—140 miles, 4-6-8-in., under way, south of Rolla, Kans., to Guymon, Okla. Reese Bros. Const. Co. E. H. Reese, spreadman at Hugoton, Kans.

• **Northwest Natural Gas Co.**—750 miles, planned, Washington, Oregon, and Idaho.

24-in., Eastport, Idaho, to Monroe, Wash.

18-in., Monroe to International boundary near Lynden, Wash.

22-in., Monroe to near Seattle, Wash.

20-in., Seattle to Portland, Ore.

• **Ohio Fuel Gas Co.**—31 miles, 20-in., planned, Licking County to Richland County, Ohio.

22 miles, 16-in., planned, Dayton, Troy, Piqua, and Sidney, Ohio.

23 miles, 16-20-in., planned, Wellington to Elyria, Ohio; 16 miles, 20-in., planned, Benton Station to Crawford Station; 18 miles, 20-in., Crawford Station to near Columbus; 16 miles, 16-in., planned, Berlin to Sandusky, Ohio.

74 miles, 3 to 20-in., planned, Hocking, Knox, and Ashland counties, Ohio.

47 miles, 20-in., planned, Benton Township, Hocking County, to Columbus, Ohio.

61 miles, planned, northern and southwestern Ohio.

33 miles, 20-in., proposed, Jefferson to Seneca, Ohio.

**Oklahoma Natural Gas Co.**—50 miles, 10-in., under way, Sapulpa to Chouteau, Okla. A. O. Smith. 6-53.

• **Pacific Gas & Electric Co.**—50 miles, 12-16-20-in., planned, Fresno to Merced, Calif.

(Section 1) 16-in., Burrel to near Easton, Calif.

(Section 2) 20-in., Holm to Topock-Milpitas line.

(Section 3) 12-in., parallel existing Madera-Livingston line, planned, Monterey to Fort Ord to Castroville; Napa Wye to Shellville; Cotati to Santa Rosa, Calif.

170 miles, 34-in., proposed, main-line loops along Topock, Ariz., to Milpitas, Calif.

**Pacific Gas & Electric Co.**—141 miles, 34-in., under way, parallel sections along Topock-Milpitas line. Engineers Pipe Line, Ltd. Summer 1953.

• **Pacific Northwest Pipeline Corp.**—1,466 miles, proposed, Ignacio, Colo., to Bellingham, Wash.

380 miles, proposed, laterals and spurs off main line to Pocatello, Idaho, to Yakima, Wash.

**Panhandle Eastern Pipe Line Co.**—70 miles, 24-26-in., under way, looping from Sneed, Tex., to Emporia, Kans.

174 miles, 30 and 26-in., contracted. Tuscola, Ill., eastward—looping present system: R. A. Conyes, contractor.

26-in., Edgerton, Mich., Anderson Brothers

30-in., looping in Tuscola, Ill.

30-in., looping in Montezuma, Ind.

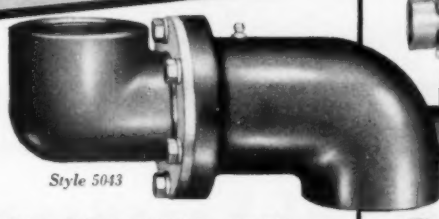
30-in., looping in Zionsville, Ind.

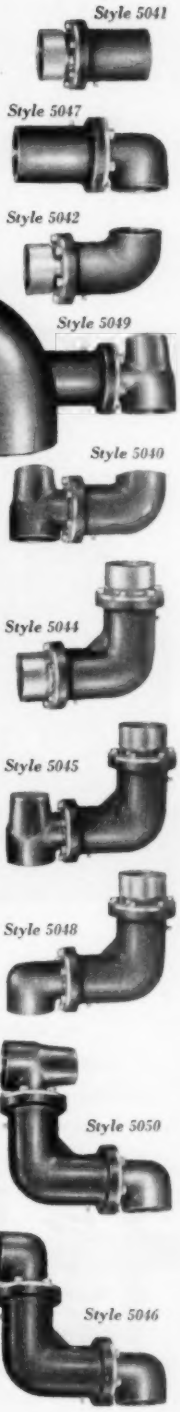
• **Panhandle Eastern Pipe Line Co.**—23 miles, planned, Peoria County, Illinois.

• **Peoples Natural Gas Co.**—25 miles 6 to 24-in., planned, Cambria and Blair counties, Pennsylvania.

• **Permian Basin Pipeline Co. (Northern Natural)**—163 miles, 16-30-in., proposed, Permian basin and eastern New Mexico.


BARCO
SWING JOINTS

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BARCO'S new, attractively priced, all-steel ball bearing *Swing Joints* are designed specifically for refinery *service* on loading or unloading lines handling gasoline, oil, lube oil, LP gas, petro-chemicals, and other fluids.

**MANY STYLES**—The Barco line is complete with single swing, double swing, and counterbalance styles to meet every need! Sizes 2", 2½", 3", 4".

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**SIMPLE CONSTRUCTION**—Joints can be disassembled for inspection without disconnecting piping. O-rings are easily renewable in the field.

**ENGINEERING RECOMMENDATION**—Barco will be glad to give you detailed recommendations on joints to use and suggested arrangements for complete loading and unloading assemblies.

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**(A Chicago Suburb)**

*BARCO—The Only Truly Complete Line of Flexible Ball, Swivel, Swing, and Revolving Joints*

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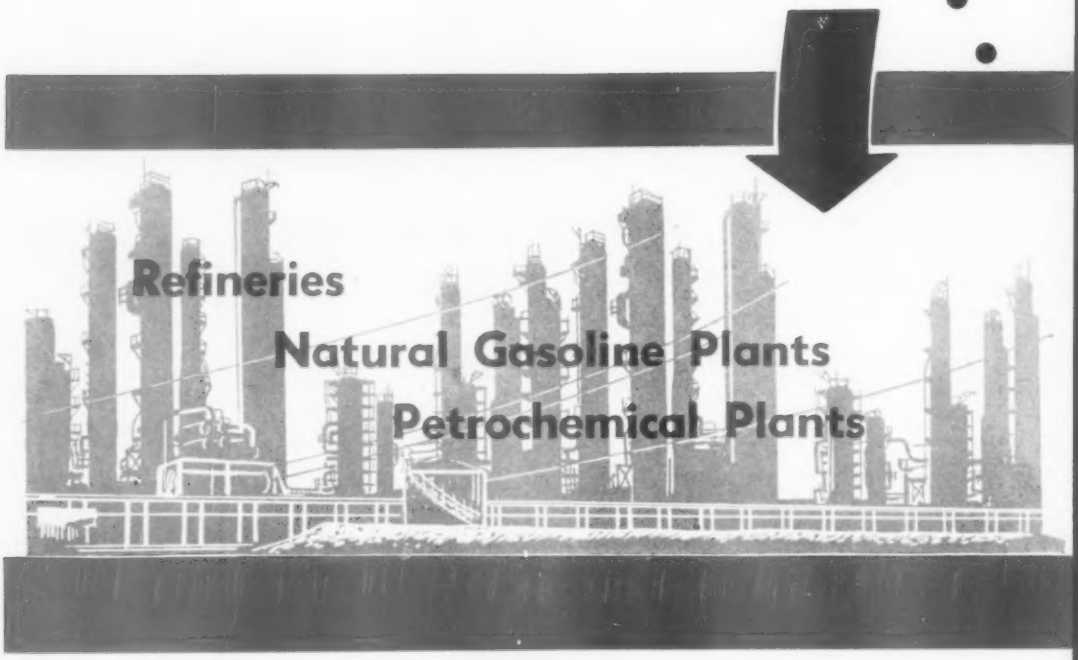


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**SUPPLY DIVISION**

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**Pumps, Motors, Engines,**
**Paint, Tools, Special Equipment**

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**Stocks and facilities at your J&L supply store are molded to your requirements by your inquiries. These we earnestly solicit.**

• **Phillips Petroleum Co.**—125 miles, 2 to 24-in., planned, Midland, Upton, Glasscock, and Reagan counties, Texas. Completion date 6-53.

28 miles, 10-in., planned, Bayou Plant to Adams Terminal. Completion date 7-53.

• **Public Service Co. of Colorado**—95 miles, proposed, Douglas Creek and other gas fields to Grand Junction, Colo., area.

• **Public Service Co. of North Carolina**—83 miles, 8-in., planned, Kings Mountain to Asheville, N. C. Completion date 3-1-53.

• **Rockland Light & Power Co.**—22 miles, 8-in., proposed, Orangetown to Tompkins Cove, N. Y.

• **Shenandoah Gas Co.**—39 miles, 3-4-8-in., proposed, Middleton, Va., to Martinsburg, W. Va.

• **South Carolina Natural Gas Co.**—160 miles, 16-12-10-in., proposed, Aiken, S. C., to cities of Columbia, Summerville, and Charleston, S. C.

• **South Georgia Natural Gas Co.**—339 miles, 2-12-in., planned, Phoenix, Ala., to Tallahassee, Fla. (a) 12-in., Phoenix, Ala., to Albany, Ga., (b) 10-in., Albany, Ga., to Moultrie, Ga., (c) 8-in., Moultrie, Ga., to Tallahassee.

• **Southern California Gas Co.**—35 miles, planned, Antelope Valley, California.

**Southern California Gas Co. and Southern Counties Gas Co. of California**—45 miles, 30-in., contracted, looping on line from Arizona border to Los Angeles. J. B. Gill.

81 miles, 30-in., contracted, Whitewater to Desert Center, Calif. J. B. Gill.

Contracted, looping between Blythe and Colorado River and on westward of Indio. J. B. Gill.

• **Southern California Gas Co., and Southern Counties Gas Co.**—73 miles, 30-in., planned, loops on main line from Blythe to Los Angeles.

**Southern Natural Gas Co.**—1,235 miles, 24 to 4½-in., contracted, Louisiana, Mississippi, Alabama, and Georgia, and South Carolina. Houston Contracting and H. C. Price. Fall 1953.

Gwinville, Miss., to Franklinton Junction, La.

Lateral from Franklinton Junction, La., to Sand Hook field, Mississippi.

Franklinton Junction, La., to Duck Lake gas field, Louisiana.

Duck Lake gas field, Louisiana, to Lake Sand field, Louisiana.

• **Southern Union Gas Co.**—21 miles, 20-in., planned, Albuquerque, N. M.

30 miles, 12-20-in., contracted, San Juan County, New Mexico. R. H. Fulton & Co.

• **Southwest Gas Corp., Ltd.**—26 miles, proposed, from P.G.&E. line to Victorville, Calif.

• **Tennessee Gas Transmission Co.**—574 miles, 30-in., planned, Kinder, La., northeast through Louisiana, Mississippi, to Portland, Tenn.

130 miles 26-30-in. loops in Texas, Louisiana, Ohio, and Pennsylvania.

45 miles, 20-in., loops, Buffalo to U. S.-Canadian border near St. Catharines.

158 miles in Louisiana and Texas.

**Tennessee Gas Transmission Corp.**—50 miles, 30-in., under way, Sinton and El Campo, Tex. Houston Contracting Co. 4-53.

**Texas Eastern Transmission Corp.**—315 miles, 24-in., under way, Provident City, Tex., to Castor, La. Brown & Root, Inc.

Provident City to Waller, Tex. Associated Pipe Line Contr., Inc.

Waller to Corrigan, Tex. Anderson Bros.

Corrigan to Center, Tex. Williams Bros.

Center, Tex., to Castor, La. Trojan Const. Co., Inc.

80 miles, under way, Warren to Livingston, Tex. Anderson Bros. 5-20-53.

• **Texas-Ohio Gas Co.**—1,435 miles, 30-in., proposed, Hidalgo County, Texas, through Arkansas, Mississippi, Tennessee, and Kentucky on to Spencer, W. Va. Completion date 6-30-53.

• **Trans-Northwest Gas, Inc.**—246 miles, proposed, International Boundary near Osoyoos, B. C., to Washington and Idaho.

275 miles, branch lines.

• **Union Oil Co. of California**—40 miles, 8-10-in., planned, San Joaquin Valley and Los Angeles Basin.

• **United Fuel Gas Co.**—50 miles, 20-24-in., proposed, Wood County to Lanham, W. Va.

• **United Gas Pipe Line Co.**—44 miles, 20-in., planned, Lirette field to Harvey, La.

31 miles, proposed, offshore Gulf of Mexico to Terrebonne Parish, Louisiana.

• **United Natural Gas Co.**—50 miles, 12-in., planned, Elk County to Jefferson County, Pennsylvania.

• **Utah Natural Gas Co.**—96 miles, 16-18-in., proposed, Clear Creek field near Price to Salt Lake City, Utah.

18-in., Clear Creek to Provo, Utah.

16-in., Provo to Salt Lake City, Utah.

**Virginia Natural Gas Co.**—153 miles, Buckingham to Richmond and Portsmouth, Va.

**Warren Petroleum Corp.**—78 miles, 2-24-in., proposed, Lovington, N. M. Completion date 9-53.

**Westcoast Transmission Co., Ltd.**—(See foreign natural gas pipe lines).

• **Western Slope Gas Co.**—79 miles, 8-in., planned, Garmesa to West Douglas Creek, Colo. Foutz & Bursum Const. Co. 10-53.

**Wilcox Trend Pipe Line Co.** (Harry Bass Drlg. Co.)—157 miles, 14-16-20-in., under way, gathering system for delivery to proposed Texas Eastern terminal at Provident City, Tex. (60 miles laterals). H. B. Zachry. Completion date 5-53.


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Type DA-400 Series pressure controls incorporate a single bourdon tube which actuates two independently adjustable Mercoid magnet operated mercury switches to accomplish various circuit operations. Ranges 0-30 psi to 300-2500 psi.

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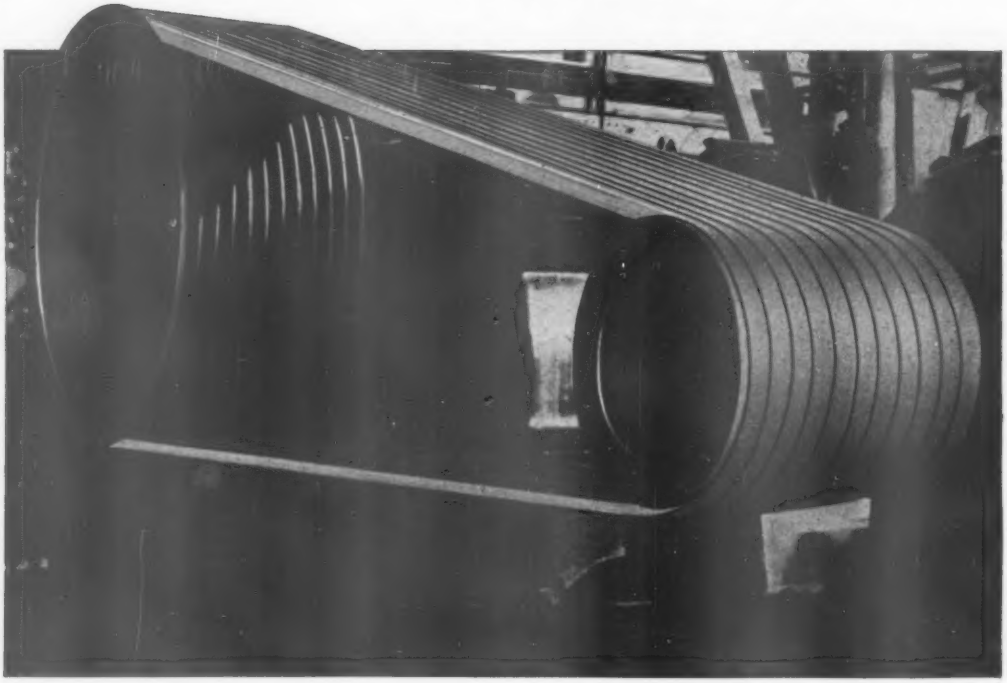
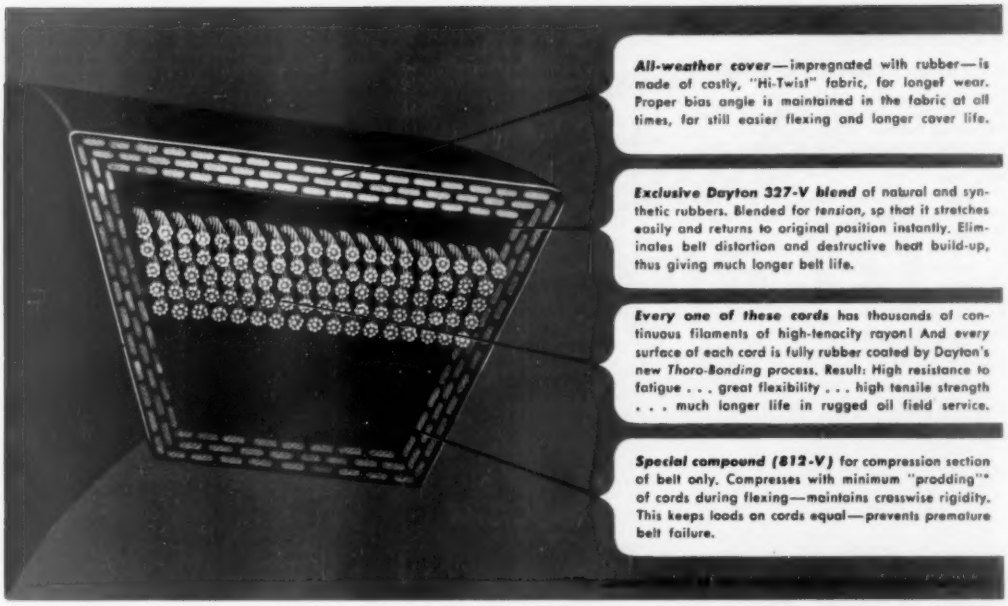
*Refinery and Industrial Equipment*

# Preventive Maintenance

## REALLY PAYS OFF ON TOUGH DRILLING




***All-weather cover*** — impregnated with rubber — is made of costly, "Hi-Twist" fabric, for longer wear. Proper bias angle is maintained in the fabric at all times, for still easier flexing and longer cover life.
***Exclusive Dayton 327-V blend*** of natural and synthetic rubbers. Blended for *tension*, so that it stretches easily and returns to original position instantly. Eliminates belt distortion and destructive heat build-up, thus giving much longer belt life.
***Every one of these cords*** has thousands of continuous filaments of high-tenacity rayon! And every surface of each cord is fully rubber coated by Dayton's new *Thoro-Bonding* process. Result: High resistance to fatigue . . . great flexibility . . . high tensile strength . . . much longer life in rugged oil field service.
***Special compound (812-V)*** for compression section of belt only. Compresses with minimum "prodding" of cords during flexing — maintains crosswise rigidity. This keeps loads on cords equal — prevents premature belt failure.

# AND PUMPING DRIVES!

What happens when a mud pump drive fails? Your drilling rig stops . . . the drill may freeze . . . you *may* lose the hole. And one loss is *certain*—the "make hole" time that's lost while the mud pump is out of action. It all adds up to a mighty costly drive failure.

And that's why it is sound preventive maintenance to make sure that all the drives on drilling rigs and other oil field machinery are belted with dependable Dayton Thorobred V-Belts. They're the belts that have made a name for themselves in tough oil field usage!

There's no question *why* Dayton Thorobreds are so reliable—the construction features shown above are the reasons behind their tested dependability. Those features combine to make a belt that's better *all the way through*—the kind of belt you'd expect from the company that made the *first* V-Belt . . . the company that first successfully bonded rubber to rayon cords in belts . . . the pioneers who developed the first oil proof belts. Try Thorobreds on *your* rig, and see for yourself.

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**Dayton Service** is as close as your telephone! Look up your Dayton Distributor (See "Belting" in the classified section of your local phone book) and let him show you how Thorobred V-Belts can lick your drive problems. He can serve you from conveniently located warehouse stocks, and has the engineering staff of Dayton Rubber ready to help you out with any "tough" problem that's giving you trouble.

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Duvall County to Goliad County, Texas. H. B. Zachry. 5-53.

### Foreign Crude-Oil Pipe Lines

**Arabian American Oil Co.**—16 miles, 12-in., under way, loops on Al Kobar, Saudi Arabia to Bahrein Island, submarine lines.

**Basrah Petroleum Co.**—72 miles, 24-in., under way, Zubair to Fao. Completion date May 1953.

• **Cia. de Petroleo Ganso Azul, Ltd.**—48 miles, 4-in., planned, Ganzo Azul field to Pucalpa on upper Ucayali River, Peru.

• **Creole Petroleum Corp.**—25 miles, 34-in., planned, Lagunillas to La Salina (State of Zulia). Completion date April 1953.

**Direccion General de Yacimientos Petroliferos Fiscales**—409 miles, under way, Plaza Huincul to Bahia Blanca, Argentina.

**Interprovincial Pipe Line Co.**—135 miles, 24-in., looping from Regina to U. S. border.

• **National Iranian Oil Co.**—38 miles, 12-in., planned, Lali to Masjid-i-Sulaiman.

27 miles, 12-in., planned, Kut-Abdullah to Zergan.

• **Petroleos Mexicanos.**—145 miles, 12-in., considered, 18 de Marzo field via Reynosa to Monterrey, Mexico.

100 miles, planned, Isthmus of Tehuantepec, Jose Colomo to El Plan field, Minatitlan.

72 miles, 12-in., proposed, Poza Rica to Atzacapotzalco, Mexico.

**Petroleos Mexicanos.**—125 miles, 10-in., under way, Jose Colomo to El Plan, Mexico.

• **Saskatoon Pipe Line, Ltd.**—56 miles, 6-in., planned, Milden to Saskatoon, Sask.

**Texas Petroleum Co.**—60 miles, 4-6-in., under way, Pta. Nino to La Dorada.

• **Trans Mountain Oil Pipe Line Co.**—30 miles, planned, Vancouver, B. C., terminal to Ferndale, Wash.

**Trans Mountain Oil Pipeline Co.**—711 miles, 24-in., under way, Edmonton, Alta., to Vancouver, B. C. Canadian Bechtel, Ltd., engineers. Completion date 8-53.

Edmonton to Acheson, Canadian Pipe Line Const. 8-53.

Acheson to Blue River, B. C., Comstock Midwestern. 8-53.

Blue River, B. C., to Coquehalla, B. C., Mannix, Ltd. 8-53.

Coquehalla to Vancouver, B. C., Comstock Midwestern. 8-53.

• **Yacimientos Petroliferos Fiscales Bolivianos.**—170 miles, 4-in., planned, Bermejo to Tupiza, Bolivia.

### Foreign Products Pipe Lines

**Colombian Ministry of Petroleum.**—115 miles, 4-in., begin 1953, La Dorada to Cartago, Colombia, Williams Bros. Engineers.

93 miles, 8-in., begin 1953, Cantimplora to Dorada, Colombia, William Bros. Constructors.

• **Empresa Nacional del Petroleo**—80 miles, 6⅝-in., planned, Concon to Santiago, Chile.

**Empresa de Ferrocarriles Ecuatorianos.**—50 miles, 6-in., contracted, Guayaquil to Palmira, Ecuador. J. A. Jones, contractor; C.R.C. Engineering Co., engineers.

• **Governments of Southern Rhodesia and Portuguese East Africa.**—200 miles, considered, Beria, Portuguese Mozambique to Umtalia, Southern Rhodesia.

• **Petroleos Mexicanos.**—124 miles, 6-in., planned, Lagos to Guadalajara, Mexico.

54 miles, 6-in., planned, Lagos to Aguascalientes, Mexico.

82 miles, 8-in., planned, Salamanca to Lagos, Mexico.

• Shell Co. of Australia.—58 miles, 8-in., planned, Geelong, Melbourne to Newport, Australia.

• **Sun Pipe Line Co. of Canada.**—200 miles, 8-in., planned, Sarnia, Hamilton, Toronto, Ont.

• **United States Government.**—375 miles, 12-in., planned, St. Nazaire to Melun and Metz, France.

### Foreign Natural-Gas Pipe Lines

• **Azienda Generale Italiana Petroli.**—110 miles, 12-14-16-in., Start 11-52. Cortemaggiore to Genoa. Completion date 11-53.

**Azienda Generale Italiana Petroli**—90 miles, 12-in., under way, Cortemaggiore to Bologna, Italy, SNAM crews.

120 miles, 16-in., under way, Cremona Porto Mar to Ghera, Italy, Montubi, contractor.

40 miles, 12-in., under way, Ripalta-Bergamo, Italy.

**Direccion General del Gas del Estado**—310 miles, 8-in., under way, Plaza Huincul to Neuquen, Argentina, to the vicinity of General Conesa, Argentina.

• **Empresa Nacional del Petroleo**—80 miles, 10¾-in., planned, Concon to Santiago, Chile.

• **Northwest Natural Gas Co.**—950 miles, 24-in., planned, Alberta fields to Vancouver, B. C., Seattle, Wash., and Portland, Ore.

**Petroleos Mexicanos.**—205 miles, 16-in., under way, Monterrey to Torreon, Mexico.

• **Petroleos Mexicanos.**—440 miles, 20-in., planned, Brazil to Tampico to Poza Rica, Mexico.

• **Trans-Canada Pipe Lines, Ltd. (Canadian Delhi Oil Co.)**—2,247 miles, 14 to 30-in., proposed, Alberta to Toronto to Montreal.

747 miles, 8 to 24-in., gathering system in Alberta.

• **Westcoast Transmission Co., Ltd.**—1,110 miles, 24-in., planned, Dawson Creek, B. C., through Pine Pass and Fraser River Valley to Kamloops, Princeton, and Vancouver to Portland. Ford, Bacon & Davis, engineers.

280 miles, 20-in., planned, Pincher Creek to Montana on to Spokane, Wash. Ford, Bacon & Davis, engineers.

138 miles, 20-in., planned, Sumas to Tacoma, Wash.

139 miles, 18-in., planned, Tacoma, Wash., to Portland, Ore.

• **Western Pipe Lines.**—833 miles, 24-in., proposed, from southern Alberta, eastward across the Canadian prairies, serving principal towns and cities along the route to a point near the International boundary.


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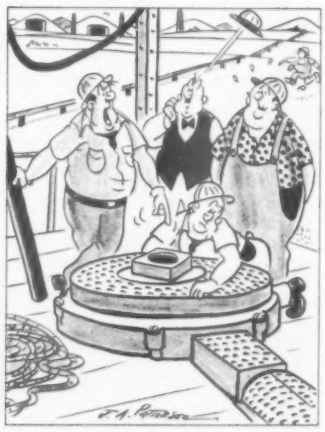

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## . . . Here's What it Means to You in Terms of Valve Service

Flat mating surfaces within .000005", or less, of every set of Okadee valve discs and seats mean absolute shut-off of any material from ammonia gas to asphalt.

How long does this seal last in service? We honestly don't know. Tests under working conditions with propane were stopped after 269,000 operating cycles when no wear or seal failure could be detected. And Okadee valves do not have to be babied in service on corrosive or abrasive materials . . . Thousands of boilers have had Okadee blow-down valves in continuous, trouble-free service for fifteen years or more. If Okadee size-pressure-temperature ranges include your valve applications, Okadee installation will end your problems of valve performance once and for all.

Okadee valves are available in single-disc (one direction) and double-disc (two directions) types; screwed or flanged; ½" to 6" in standard A.S.A. dimensions; steel or semi-steel bodies (other materials to order); stainless steel or stellite seat facings; levers, rack-and-lever, worm-gear, hydraulic, pneumatic, automatic on-off control.

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# *the dream of* Oliver Grebe

Oliver Grebe was an important guy
the head of a drilling crew,
but he was as nervous as a fly
and was always in a stew.

He kept his men all upset
and worried all the time,
about the problems to be met
he would cuss and whine.

Now after a wild and wooly day
when Grebe was especially bad,
he went home to hit the hay
and left his crew all mad.

He cursed the day that he was born,
and at his boarding house
he gave the landlady a look of scorn
said she, "He certainly is a louse."

This particular night he went to bed
and had an unusual dream,
he saw himself all stretched out dead,
and there was his drilling team.

All dressed up in their Sunday best
and singing this joyful song,
"Old Oliver Grebe is dead—the pest
will no longer do us wrong.

If he had only inquired of us
we'd have solved his problems easy.
We know that there's no need to fuss
when the rig is running wheezy.

Just look no further than United Supply
Their stores are not far away . . .
rig problems to them are easy as pie
they reduce down time and delay."

Oliver Grebe woke up with a start
he was shaking like a leaf,
"Say, I haven't been very smart
to cause my crew this grief.

On United Supply I'll always rely,
they'll handle all my trouble—
Whenever the old rig starts going awry
we'll get repair parts on the double.

Now Oliver Grebe is a different man
He's loved by everyone,
The kids all call him Superman
His crew thinks he's A-1.

You see, he's found out about United
and how they deliver fast,
and that no one is ever slighted—
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# PIPE LINES

## Oil Movement Up

### 55 lines moved 3.3 billion barrels in 1952, ICC says

WASHINGTON. — The 55 largest pipe lines handled 3,330,092,465 bbl. of oil last year and had an aggregate transportation revenue of $528,566,367, the Interstate Commerce Commission reports.

This compared with 3,162,965,942 bbl. of oil moved and a transportation revenue of $491,422,315 in 1951, an increase of approximately 7.5 per cent in both volume in receipts.

Nearly two-thirds of the total movement was handled by 11 systems, ICC figures show.

Seventeen companies reported a decline in volume from 1951 to 1952 but only 13 reported a drop in revenue, in 2 instances in the face of higher volume.

**Big carriers . . .** The 11 pipe-line companies handling more than 100,000,000 bbl. in 1952 had volume and revenue as follows:

Humble Pipe Line Co., 295,079,463 bbl. and $41,976,790 against 303,396,698 bbl. and $43,172,361 in 1951; Texas Pipe Line Co. 209,987,095 bbl. and $33,797,133 against 201,102,727 bbl. and $29,602,417; Gulf Refining Co., 198,369,586 bbl. and $30,747,635 against 186,360,421 bbl. and $30,211,581; Buckeye Pipe Line Co. 197,345,943 bbl. and $10,575,956 against 167,936,495 bbl. and $8,751,030;

Interstate Oil Pipe Line Co., 185,233,421 bbl. and $21,253,666 against 176,480,642 bbl. and $20,244,654; Service Pipe Line Co., 183,345,579 bbl. and $57,556,044 against 174,429,786 bbl. and $55,129,567; Sinclair Pipe Line Co., 169,967,557 bbl. and $37,140,595 against 163,891,503 bbl. and $37,069,273; Magnolia Pipe Line Co., 163,653,183 bbl. and $31,262,474 against 165,496,523 bbl. and $32,139,147; Ohio Oil Co., 150,779,109 bbl. and $14,968,294 against 138,972,395 bbl. and $13,600,535; Shell Pipe Line Corp., 142,090,186 bbl. and $30,213,621 against 139,177,159 bbl. and $27,128,356; and Phillips Pipe Line Co., 104,513,234 bbl. and $19,842,399 against 78,400,607 bbl. and $11,937,580.

**Big revenues . . .** Companies with high transportation revenues on lesser volumes included: Atlantic Pipe Line Co., $10,843,362 on 79,689,261 bbl. against $10,056,949 on 74,286,662 bbl.; Great Lakes Pipe Line Co., $34,332,240 on 72,561,715 bbl. against $29,468,209 on 61,895,983 bbl.

Mid-Valley Pipeline Co., $15,040,378 on 45,262,894 bbl. against $14,082,170 on 44,428,260 bbl.; Plantation Pipe Line Co., $18,788,416 on 60,665,693 bbl. against $12,172,847 on 42,161,417 bbl., and Texas-Empire Pipe Line Co., $11,141,501 on 87,763,335 bbl. against $10,045,135 on 81,884,137 bbl.

## Colorado Interstate Seeks New Transmission Lines

WASHINGTON.—Colorado Interstate Gas Co. has filed two applications with the Federal Power Commission to build natural-gas-transmission facilities at a total estimated cost of $43,155,249.

One application seeks permission to construct a 365-mile, 22-in. pipe line from a connection near Green River, Wyo., to Denver. The proposed system would be built by Pacific Northwest Pipeline Corp. Also included would be a 5,500-hp. compressor station at Green River and necessary metering and regulating facilities. Estimated cost is $23,298,653.

The other application proposes construction of 49 miles of 20-in. gas pipe line and a total of 24,860 hp. in compressor capacity at new and existing stations. Estimated cost of this project, in Colorado, Oklahoma, Texas, and Kansas, is $19,856,596. This initially would increase the sales capacity of the company's transmission system by 82,500,000 cu. ft. of gas per day.

## River Construction Corp. Gets Interstate Contract

SHREVEPORT. — River Construction Corp. of Fort Worth has been awarded a contract by Interstate Oil Pipe Line Co. for work on two related crude-oil trunk-line projects.

One project involves construction of 22 miles of 18-in. crude-oil trunk line from the Louisiana-Texas border to the site of Finney pump station about 10 miles southeast of here in Caddo Parish. The second project is construction of 28 miles of 22-in. trunk line from Finney station site south and east to about 5 miles northwest of Coushatta in Red River Parish.

Work on the 18-in. line will start the end of this month. On completion the contractor will begin work on the 22-in. line. Completion of both projects is expected by June 15.

The two lines are part of Interstate's expansion program for the Shreveport-


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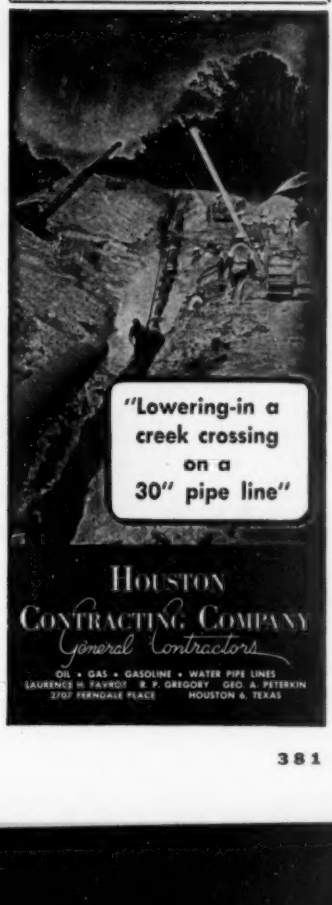
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Baton Rouge trunk-line system. Both projects will be carried out under general supervision of J. B. Barnett, Interstate's district superintendent.

## T.G.T. Initiates Program

HOUSTON.—Tennessee Gas Transmission Co. has initiated a 1953 construction program to enlarge its natural-gas pipe-line system, according to Charles S. Coates, senior vice president.

The program consists of laying about 369 miles of pipe line in Texas, Louisiana, Tennessee, Kentucky, and Pennsylvania, enlarging two of its existing 25 compressor stations, and completing the twenty-sixth new station.

## Lone Star Steel Co.'s New Pipe Mill Operating

DAINGERFIELD, Tex.—Lone Star Steel Co. has placed in operation its new electric-weld pipe mill near here after successfully completing breaking-in operations. In full operation, the mill will manufacture more than 400,000 tons of oil-country tubular goods annually.

The plant now is using steel obtained from outside sources, but four open-hearth furnaces and the rolling mills are scheduled to go into operation April 1.

Later in the summer Lone Star will become a completely integrated steel plant, manufacturing tubular goods from steel manufactured and rolled at the company's plant here.

## Oklahoma Natural Lets Contract for 50-Mile Line

TULSA.—Construction of approximately 12 miles of 20 and 24-in. pipe line to replace a 12 and 16-in. line southwest of Oklahoma City will start this week, Joseph Bowes, president of the Oklahoma Natural Gas Company, announced.

In addition, construction of approximately 50 miles of 18-in. line from Sapulpa to the Pryor area will start around April 15.

Bowes said the new 20 and 24-in. line will run from southwest of Oklahoma City south to the South Canadian River.

"This new line is being constructed so that we will be able to meet the needs of anticipated expansion in our load," Bowes said.

The new 18-in. line will serve the John Deere Co.'s chemical-fertilizer plant, now under construction southeast of Pryor, and the Grand River Dam Authority steam plant, located in the same vicinity.

The lines will be built, under contract, by Engineering Construction Co., Tulsa, low bidder on the two jobs.

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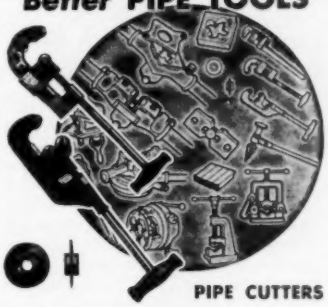
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# NATURAL GAS

## Consolidated Hearings Set For Increasing Gas Service

WASHINGTON. — Consolidated hearings were to get under way here before the Federal Power Commission March 25 on applications of Texas Illinois Natural Gas Pipeline Co. and Chicago District Pipeline Co., subsidiaries of Peoples Gas, Light & Coke Co.

Texas Illinois wants to increase daily delivery capacity of its pipe-line system from the presently authorized 374,000,000 cu. ft. to 504,000,000 cu. ft. daily. Plans include building of six new compressor stations and additional units in existing stations, a suspension bridge across the Mississippi River, and lateral pipe lines to connect additional gas reserves to the company's system. Estimated cost is $42,148,000.

Authority to construct about 35 miles of natural-gas-transmission line in the Chicago area is sought by Chicago District. This would cost an estimated $5,500,000.

## Columbia Gas System Gets O.K. on Eight New Projects

WASHINGTON.—The Federal Power Commission's presiding examiner has filed a decision, subject to review, authorizing eight subsidiaries of Columbia Gas System, Inc., to carry out natural-gas pipe-line-construction projects. The projects include:

1. Atlantic Seaboard Corp., two compressor stations in Pendleton and Hardy counties, West Virginia.

2. Virginia Gas Transmission Corp., removal of limitation of 55,000,000 cu. ft. of gas daily on deliveries to Commonwealth Natural Gas Co., Richmond.

3. Central Kentucky Natural Gas Co., 8.8 miles of line looping an existing line extending north through North Means, Ky., to provide greater safety and continuity of service to the Cincinnati market area.

4. United Fuel Gas Co., expansion of underground-gas storage operations, a 21.5 pipe line, plus 4,660 hp. in new compressor capacity; a new 880-hp. compressor station and an additional 3,950 hp. at an existing station near Charleston, W. Va.

5. Manufacturers Light & Heat Co., 9.3 miles of pipe line and a measuring and regulating station, and retirement of 15.6 miles of line, a compressor station, and compressor unit.

6. Natural Gas Co. of West Virginia, 21.3 miles of pipe line and retirement of 14.7 miles of old line, plus two compressor units.

7. Home Gas Co., similar facilities in connection with Manufacturer's application.

8. Ohio Fuel Gas Co., 19 miles of pipe line in Chemung, Tioga, and Broome counties, New York.

## New England Gas Service Arguments Under Way

WASHINGTON. — A motion requesting the Federal Power Commission to direct Texas Eastern Transmission Corp., Shreveport, to submit evidence it has adequate gas supply to serve Algonquin Gas Transmission Co., Boston, in addition to existing customers, is being argued here.

Tennessee Gas Transmission Co., Houston, and Northeastern Gas Transmission Co., Springfield, Mass., filed the motion February 3. The FPC is now holding hearings on competitive applications of Algonquin and Northeastern for natural gas service in New England. Northeastern is a subsidiary of Tennessee, its supplier.

## Panhandle Eastern Hearing Set by FPC For April 6

WASHINGTON. — A Federal Power Commission hearing will begin here April 6, on an application by Panhandle Eastern Pipe Line Co., Kansas City, requesting approval of the abandonment, starting September 1, of natural-gas service to Texas Gas Transmission Corp., Owensboro, Ky., under a 1938 contract between Panhandle and Kentucky Natural Gas Corp. (predecessor in interest to Texas Gas).

Under the contract, which expires August 31, Panhandle is obligated to deliver 18 million cubic feet of natural gas per day to Texas Gas at connections between the systems of the two companies, deliveries being made near Danville and Montezuma, Ind. Panhandle claims that it is not necessary to continue the deliveries because Texas Gas has substantially increased its sources of gas supply and has made extensive enlargements of its transportation facilities.

The commission, in a concurrent order, permitted Texas Gas, Indiana Gas & Water Co., Inc., and Terre Haute Gas Corp. to intervene in the proceeding.

## Rates Paid by Texas Gas Transmission Being Checked

WASHINGTON.—An investigation has been instituted by the Federal Power Commission in connection with purchases of natural gas by Texas Gas Transmission Corp., Owensboro, Ky., from two wholly owned subsidiaries, Louisiana Natural Gas Corp. and Texas Northern Gas Corp.

The Commission at the same time consolidated the proceedings on the investigation with an earlier proceeding involving a suspended $10,500,000 annual wholesale natural-gas-rate increase proposed by Texas Gas. A hearing date will be fixed by further order.

In instituting the investigation, FPC said that on the basis of available data, it appears that the rates, charges, or classifications for and in connection with the transportation or sale of natural gas, subject to the jurisdiction of the commission, and rules, regulations, practices, and contracts relating thereto may be unjust, unreasonable, unduly discriminatory, or preferential.

## Increase in Nitric Acid Output Planned by Phillips

ETTER, Tex. — Phillips Petroleum Co. revealed here last week that construction of facilities to increase the present nitric acid capacity at Cactus plant by 110 tons per day will be started immediately.

Present government-owned nitric acid facilities are operated under lease by Phillips Chemical Co. New construction will be owned and operated by Phillips Chemical, and is expected to be completed late this year.

Chemical & Industrial Corp., Cincinnati, is handling process and design for Phillips under contract. Construction will be done by Chemical Processes, Inc.

The government-owned plant here was formerly known as Cactus Ordnance Works. It was leased in 1948 by Phillips Chemical. At that time, ammonia was the only fertilizer material being produced. Since then the firm has doubled in size the ammonia-production capacity and nitric acid-production facilities were installed, with Phillips Chemical continuing to operate both under lease from the Government.

Phillips later installed an adjacent plant, which it owns and operates, to produce ammonium nitrate and nitrogen solutions.

Increased output of nitric acid will permit production of more fertilizer in solid form to meet the U. S. Department of Agriculture's priority of fertilizer requirements.

# REFINING

## Fertilizer Plant . . .

### . . . obtains product from "spent stream" of refinery

EL PASO.—A valuable concentrated fertilizer will be produced here from a refinery byproduct or "spent stream" issuing from the refinery of Standard Oil Co. of Texas. The operation is another petroleum-industry instance of the careful upgrading and ultimate extraction of usable commodities from byproducts or wastes.

Southwest Fertilizer & Chemical Co. is now in the process of completing final construction on a superphosphate plant here to consume the entire output of spent alkylation acid from Standard's new alkylation plant. It is expected that Southwest Fertilizer will produce 30,000 tons per year of 20 per cent superphosphate.

The spent alkylation acid is received from Standard's alkylation plant by pipe line, direct to Southwest's tanks. Pumpings are received daily.

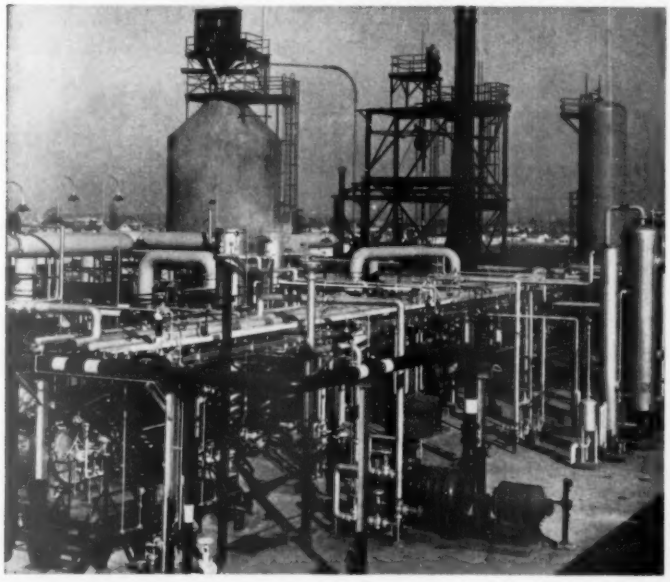
**Automatic . . .** The new superphosphate plant has been installed with automatic equipment throughout for the handling of ground phosphate rock, finished superphosphate, granulation, and bagging.

Ground phosphate rock is purchased from Florida phosphate rock mines. The material is received in hopper-bottom cars and unloaded by means of air slides.

**Phosphate rock storage . . .** The ground phosphate rock is stored in a large 30 by 50 concrete superphosphate silo. The rock moves automatically from the concrete silo to the acidulator by means of air slide and bucket elevators. The acid equipment used is the automatic self-unloading type.

Finished superphosphate is moved to the bulk storage area by means of overhead belt conveyors. After curing, the superphosphate is granulated and sold in bulk or in bags in the Southwest farm area surrounding El Paso.

The Southwest Fertilizer's installation is the first and only superphosphate plant within a 600-mile radius of El Paso. The plant actually has been producing superphosphate since the first of November. Equipment has been in-



**Union Oil's New Sulfur Recovery Plant**

**The new recovery plant at Union Oil Co.'s Wilmington, Calif., refinery is producing molten sulfur from hydrogen sulfide contained in waste refinery gases. The plant has a capacity of 50 long tons daily, and was constructed at a cost of $450,000.**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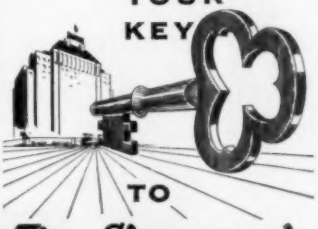

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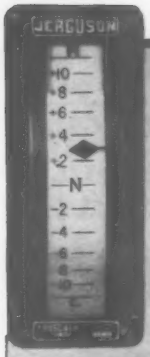


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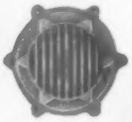

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stalled by Southwest for making complete fertilizer mixtures.

Standard of Texas' refinery at El Paso has a crude-charging capacity of 28,000 bbl. per day, and is equipped with thermal and catalytic cracking.

## Standard of Ohio Signs With Procon for New Units

LIMA, Ohio. — Standard Oil Co. (Ohio) has signed a contract with Procon, Inc., Chicago, for construction of operating units at its catalytic reformer plant at Standard's refinery here.

Construction of the catalytic reformer, to be built at a total cost of $7,500,000, is expected to start by July. Cost of the operating units to be built by Procon is estimated in excess of $4,000,000.

The 12,000-barrel-per-day catalytic reformer plant will convert low octane gasoline into high octane gasoline at a rate of 475,000 gal. daily. The Platforming process invented by Universal Oil Products Co. will be used in the reformer unit. An estimated $25,000 worth of platinum will be contained in the first charge of catalyst for the new unit.

## Kellogg Gets Contract for Socal Vacuum Flasher Unit

EL SEGUNDO, Calif.—M. W. Kellogg Co., subsidiary of Pullman, Inc., has been awarded a contract by Standard Oil Co. of California to erect a duplicate here of the world's largest vacuum flasher at Richmond, Calif.

Construction on the vacuum flasher is scheduled to begin by July. The unit will have a capacity of 55,000 bbl. of reduced crude daily, equaling the capacity of the other plant Kellogg designed and built for Standard over a year ago.

## New Epichlorohydrin Plant

HOUSTON.—A new epichlorohydrin plant just brought on stream here by Shell Chemical Corp. will assure an ample supply for the nation's present and future needs, Jan Oostermeyer, company president has announced.

Epicholorohydrin, a major component of epoxy resins, is also used in adhesives and chemical intermediates and as a stabilizer in insecticides. The raw material for epichlorohydrin is allyl chloride, of which Shell Chemical is the major producer.


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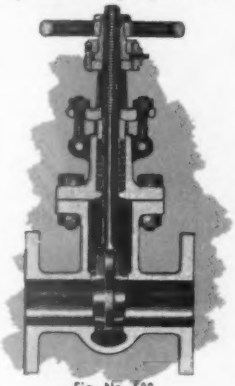

Fig. No. 500
150 Lb. Gate Valve
M. S. S. Specs.

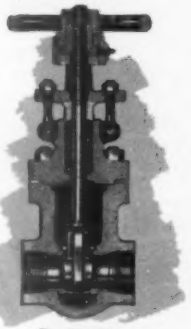

Fig. No. 51
600 Lb., Gate Valve

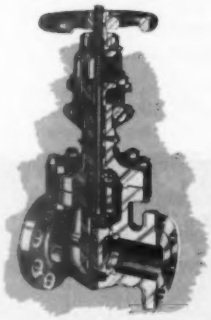

Fig. No. 350
Typical A. S. A., A. P. I.
Gate Valve

The newest addition to Pacific's line is the lightweight patterned Gate Valves, Fig. No. 8550 & 8551, (150 Lb. Series) conforming with specifications of the Manufacturers Standardization Society. Although competitively priced, this series maintains Pacific's rigid policy of high standards of quality in workmanship and materials.

Pacific's corrosion resistant, solid wedge Gate Valves, Fig. No. 500 & 501, (150 Lb. Series) are premium quality valves having design features and metal proportions beyond normal corrosion resistant requirements, and are unexcelled in this pressure classification.

Pacific's Fig. No. "500 ASA" Gate Valves are identical to Fig. No. "500" except that both pipe line flanges and bonnet flanges are heavier and the line flanges are machined with a 1/16" raised male face in accordance with A.S.A. specification B-16E. This valve is used in both old and new installations where service conditions require additional bolting and safety factors beyond the capabilities of the lightweight, flat faced flanges.

Pacific's ASA Flanged Ends (Series 150, 300 and 600), Screwed Ends (Series 600), Solid Wedged, Bolted Bonnet, O.S. & Y., Cast Stainless Steel Valves, sizes 1/2" through 2", offer new and improved design features usually found only in larger size, more expensive valves. These valves are low in cost, unusually compact and rugged and are constructed of high quality materials and manufactured to exacting standards.

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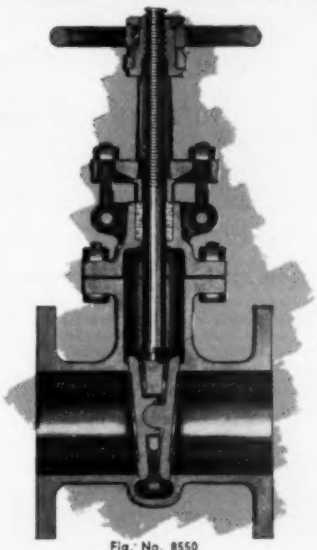

Fig. No. 8550
Lightweight Pattern
150 Lb., Gate Valve

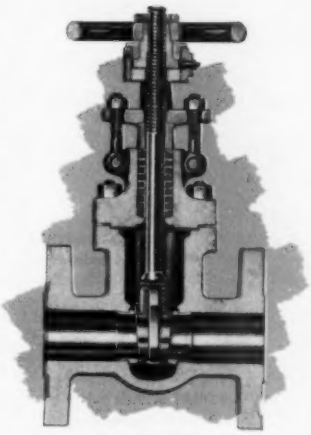

Fig. No. 3350
300 Lb. Gate Valve
A. S. A. Flanges

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# Among the Drilling Contractors

## Illinois Contractor to Drill in Nebraska Area

Dee Miller Drilling Co., Lawrenceville, Ill., is moving one of its rigs from the Illinois-Indiana-western Kentucky area to western Nebraska. Paul Guinn, formerly a tool pusher in the tri-state area, will be drilling superintendent for the company's new Nebraska operations. He will headquarter at Sidney. The company has two rotary rigs remaining in the tri-state area.

**C. G. Davis Drilling Co.,** Stephens, Ark., has a light rig running on a new 3,000-ft. well. C. G. Davis, owner of the company, and W. H. Bryant of Tyler, Tex., are drilling on the south flank of the recently opened area on the west side of the East El Dorado field, in Union County, Arkansas. The well is 1 Rogers, in the NE NE NW 24-17s-15w.

**Carter-Jones Drilling Co.,** Kilgore, Tex., has a new operation under way in the Willow Springs field, in Gregg County, East Texas, where it is drilling under contract for Blaine Dunbar at 1 Finch, I. Skillern Survey.

**Goldrus Drilling Co.,** Houston, is under contract with C. M., V. W., and P. M. Frost of Houston for an 8,500-ft. test, 1 Frost fee, at a wildcat location in the Lochridge area, Brazoria County, Texas Gulf Coast. Location is in the J. Henry Survey, A-749.

**Columbia Drilling Co.,** Houston, has a rig under contract to Federal Royalty Co. for a 7,000-ft. test, 1 Schweinle, located in the William White Survey, 3½ miles northeast of Hufsmith, eastern Harris County, Texas Gulf Coast. Location is about 1¾ miles northwest of the East Hufsmith field.

**Bateman Drilling Co.,** New Orleans, has taken a contract with F. A. Callery, Inc., of Houston, for a 10,500-ft. test in the Stella area, Plaquemines Parish, southeastern Louisiana. Rig is being moved into the location at 1 Hero Unit, in 2-15s-24e.

**T. B. Houck** will be the contractor on a deep, rank-wildcat test which will be drilled south of Lake Okeechobee, in Glade County, southern Florida. The test, contracted for Coastal Petroleum Co., is projected to 11,000 ft., where it should reach the lime pay zone producing in Humble Oil & Refining Co.'s Sunniland field, 45 miles to the southwest. The latter field is the state's only production. The test is listed as 1 Tiedtke with location in the SW SW NW 25-42s-33e.

## Petersen Drilling Co. Shreveport

PETERSEN DRILLING CO., organized in 1944 at Shreveport, is a progressive drilling contracting partnership firm operating in Louisiana, South Arkansas, East Texas, and Mississippi. Headquarters are at 306 Fairfield Building in Shreveport. A district office, which covers Mississippi and South Louisiana operations, is located on Shields Lane in Natchez, Miss.

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**Personnel . . .** Partners in the ownership are M. Q. (Jack) Petersen and Karl E. Petersen. Joe M. Coffield, production superintendent, is widely known in field and production engineering circles. Working with Coffield are M. P. (Pete) Kilgore, field production foreman; Honea L. Lewis, chief tool pusher; Cecil Hoover and John Cates, tool pushers. Layton Wells is principal accountant. H. J. DeLaune is chief geologist.

**Equipment . . .** The firm is operating three power rigs at this time. One is a Model "O" draw works driven by twin NHRS diesel engines rated at 450 hp. each at 1,800 r.p.m., and is equipped with a single 7 by 14-in. mud pump. It is mounted on a 10-ft. high, 18 by 39-ft. substructure and has a 126-ft., 340,000-lb.-capacity

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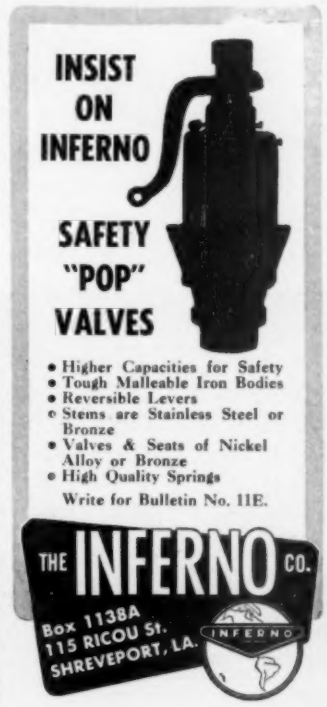

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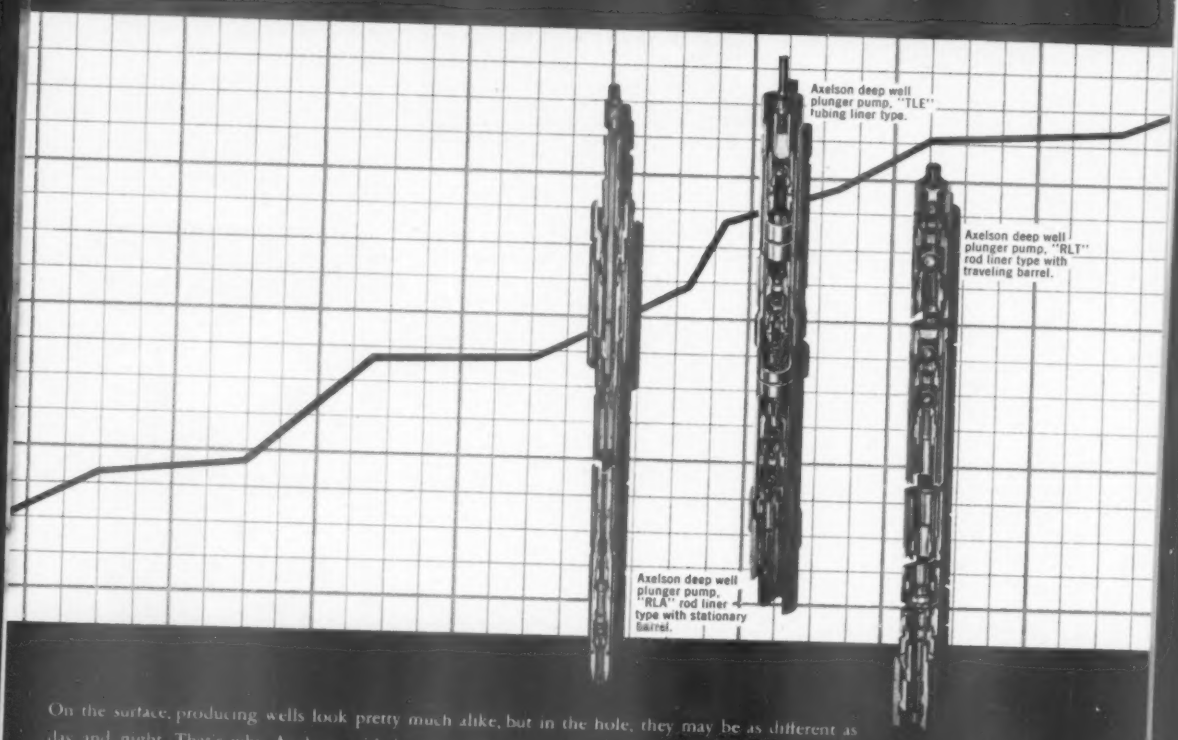
Axelson deep well plunger pump, "TLE" tubing liner type.
Axelson deep well plunger pump, "RLT" rod liner type with traveling barrel.
Axelson deep well plunger pump, "RLA" rod liner type with stationary barrel.

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PR-12

mast. Currently it is working for the firm's own account on an 8,500-ft. wildcat test in Jones County, Mississippi.

Another rig has a Model "S" draw works powered by 2 WAK motors rated at 320 hp. each at 1,200 r.p.m. Mud pump is 7 by 14-in. The mast is a 126-ft., 370,000-lb.-special-service unit mounted on a 8½-ft. high, 18 by 41-ft. substructure.

The third rig has a Model 15 draw works, driven by two Model 12103 GM twin engines which can be operated on either gas or diesel fuel. These engines are rated at 520 hp. each at 1,600 r.p.m. Mud pump is a 7 by 14-in. unit. Substructure has an 18 by 37-ft. base and is 8½ ft. high. The mast is a 126-ft., 370,000-lb.-capacity structure. This rig now is drilling for Magnolia Petroleum Co. in the Sunnyside field, Jefferson County, Mississippi.

**Performance . . .** The firm's rigs cut a total of 223,950 ft. of hole during 1952.

**Drilling & Exploration Co.,** Houston, has a rig running for Bankline Oil Co. on a wildcat test, 5-1 Mallett, 5 miles northeast of Sundown, in Hockley County, West Texas. Contract is for 10,500 ft.

**Morrison Drilling Co.,** El Dorado, Kans., is drilling for J. P. Gaty at a wildcat location, 1 Golden, 6 miles southeast of the Jester Creek pool, in the southeastern corner of Harvey County, southern Kansas. Location is in the NE SE SE 28-24s-2e.

**Milton Crow, Inc.,** Shreveport, is starting another test for Continental Oil Co. in the new Redland field, northern Bossier Parish, northern Louisiana. The test, first since the discovery well was completed last year, is located at 1 Keoun, in 29-23n-12w, ½ mile east of the discovery. Hole is projected to the Travis Peak around 7,500 ft.

**ACTIVE ROTARY RIGS***
**(United States and Western Canada)**

| Area— | Week ended 3-16-53 | Change week ended 3-9-53 | Change week ended 3-17-52 |
|---|---|---|---|
| Gulf Coast | 594 | − 5 | − 15 |
| N. & W. Tex.-N. M. | 819 | −15 | −236 |
| Ark.-N. La.-E. Tex. | 112 | + 2 | − 43 |
| Oklahoma | 325 | + 9 | − 16 |
| Kansas-S. Nebraska | 180 | +21 | + 30 |
| Illinois-Eastern | 100 | 0 | + 25 |
| Rocky Mountains | 178 | + 1 | + 8 |
| Pacific Coast | 155 | 0 | − 3 |
| Total U. S. | 2,463 | +13 | −250 |
| Western Canada | 169 | + 8 | − 10 |
| Total | 2,632 | +21 | −260 |

*Courtesy Hughes Tool Co. Trends in drilling activity in the United States and the Rocky Mountains and western Canada areas are shown on pages 418 and 419.

**Roy Rogers,** cable-tool contractor, Seminole, Okla., has a string of tools working for Consolidated Gas Utilities Corp. in the East Ulan gas field, Pittsburg County, eastern Oklahoma.

**Diamond Drilling Co.,** Odessa, Tex., has the contract for the 8,000-ft. test which Stanolind Oil & Gas Co. is starting at 1 Anderson, in 3-31-T2n-T&P Survey, in Howard County, West Texas. Location is 1½ miles from production.


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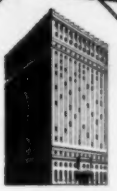

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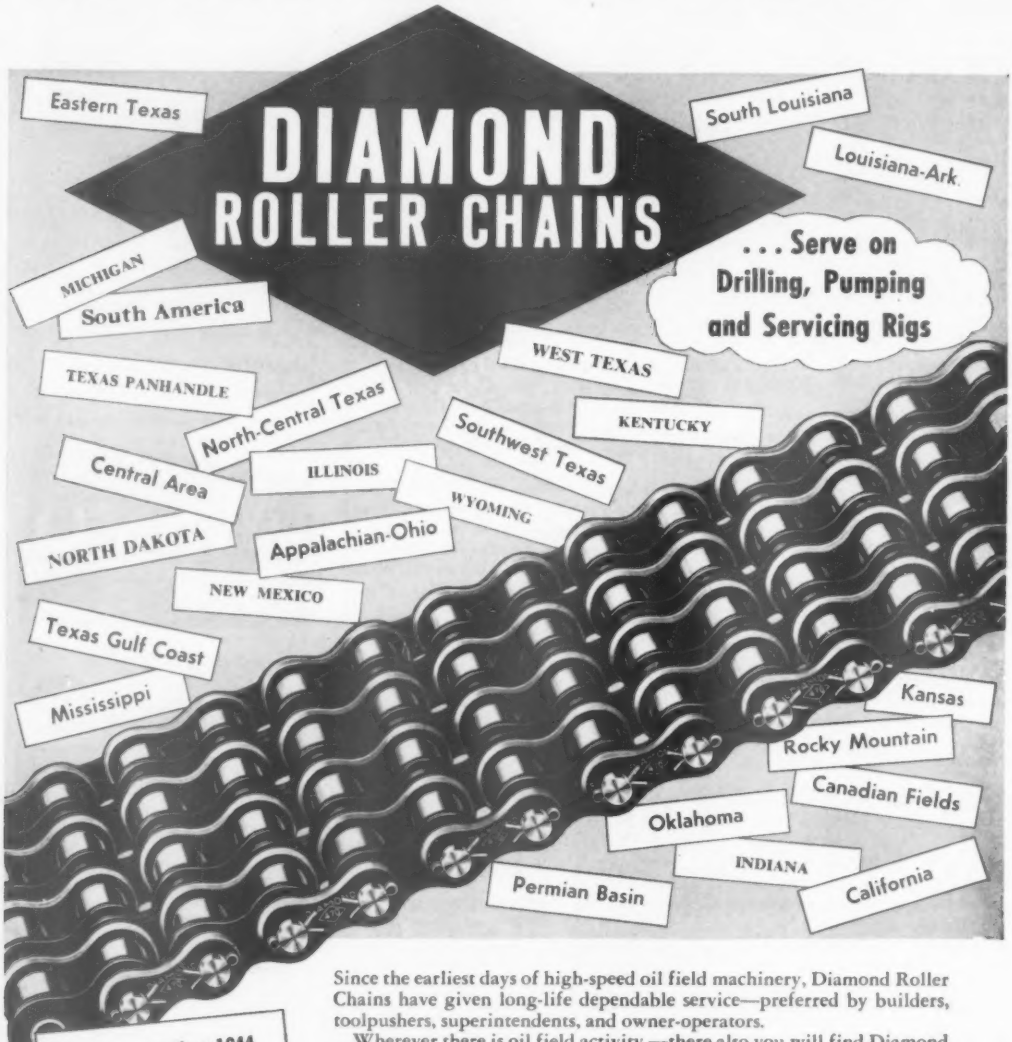
# IN ALL ACTIVE OIL FIELDS

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# EXPLORATION

## Look for Oil on Shelf Areas

**by Philip C. Ingalls**

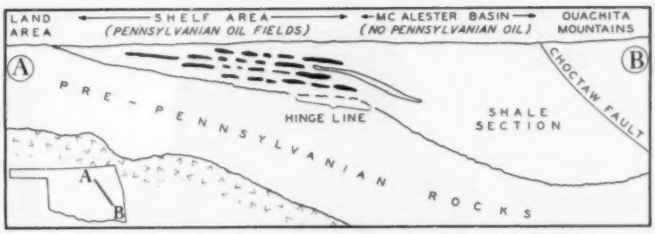
IF the findings of detailed studies of Pennsylvanian-Atoka and Des Moines sections of northeastern Oklahoma and southeastern Kansas are applicable to other sedimentary units, the place to look for oil is on the shelves of continental seas.

Indications that these findings are applicable to other areas are found in the Oligocene-Frio of the Gulf Coast, the Permian dolomites of West Texas, the Mississippian rocks of southeastern Ohio and northwestern West Virginia, the Pennsylvanian-Tensleep and Weber of Wyoming and Colorado, and many other significant oil-bearing rocks throughout the country. In each case the rocks have been found productive in the comparatively thin, porous shelf facies, and, to date at least, nonproductive in their thick deep-basin facies.

A complete story of the detailed studies of the early Pennsylvanian rocks of northeastern Oklahoma and southeastern Kansas is expected to appear in the Bulletin of the American Association of Petroleum Geologists this year. The paper, prepared by T. E. Weirich, regional research subsurface geologist, Phillips Petroleum Co., Bartlesville, Okla., convincingly shows that in this province, at least, oil accumulation is restricted to a shelf. The paper further indicates that oil originated on the shelf because, though traps are both anticlinal and stratigraphic, oil is found in ragged, lenticular sands encased in shales which are void of porous avenues to the basin depths.

Pennsylvanian oil (post-Morrow) in this province is restricted to the shelf area as shown on the accompanying schematic cross-section. That the province is not just an insignificant case to prove a point is demonstrated by the fact that the Atokan and Des Moines sands of the area have produced more than 3 billion barrels of oil to date and the ultimate recovery of this waterflood-happy area is currently estimated to be about 4 billion barrels.

Weirich divided the Atoka-Des Moines section into four units for his thickness studies. Another investigator might divide the section differently but the results would be the same. During early Pennsylvanian time the northern edge of the McAlester basin (the hinge line) migrated somewhat but, regardless of its location, the accumulation of sediments which increased gradually southeastward along the shelf, thickened abruptly southeast from the hinge line. For example: (1) In the Atoka-Hartshorne group, the thickening on the shelf is 18 ft. per mile against 170 ft. per mile in the McAlester basin. (2) In the "Lower Cherokee" (McAlester, Warner, and Savannah) the difference is 7 ft. to 40 ft. (3) In the "Middle Cherokee" (Boggy) it is 5 ft. to 26 ft. (4) In the "Upper Cherokee" (Stuart, Thurman, Senora, and Calvin) the divergence is 4 ft. per mile on the shelf against 25 ft. per mile in the basin.




**Schematic cross-section showing relation of oil accumulation to shelf area.**

In addition to the abrupt jump in rates of thickening at the hinge line there is also a change in the character of the sediments—a sharp break in porosity as the rocks leave the diversified sedimentation of the shelf for the monotonous "nonporous" section of the basin. Only the Bartlesville sand is found southeast of the hinge line and, though a prolific producer on the shelf, is salt-water bearing in the basin.

The conclusion that oil is restricted to the shelf, Weirich points out, does not condemn the McAlester basin as a future province below the base of the Atoka, where the shelf areas are still to be determined.

### HIGHLIGHTS OF WEEK'S DEVELOPMENTS

**COLORADO . . .** Forest Oil Co. recovered 2,480 ft. of gas-cut 40°-gravity oil and 360 ft. of gas and oil-cut fresh muddy water plus 90 ft. of gas and oil-cut mud on latest drill-stem test at 1 Causey, NE SW NW 23-2s-57w, Adams County discovery 4 miles southwest of Little Beaver field.

**MONTANA . . .** Sun Oil Co. and Phillips Petroleum Co. are drilling below 11,709 ft. at 1 Dynneson, C SW NE 32-24n-58e, Richland County. The wildcat has set a new depth record for the state, being about 200 ft. deeper than the previous depth record which was 11,519 ft.

**OKLAHOMA . . .** Jay Simmons' wildcat east of Blanchard in McClain County, south-central Oklahoma, has proved a third pay zone, the Tulip Creek. The new discovery is located 1½ miles northwest of a recent Bromide sand oil strike in the area in C NE NW 25-8n-4w.

**WEST TEXAS . . .** A new Devonian pool, and current developments, builds up the possibility of a deep trend connecting fields from Ector County, north to Weems in Yoakum County, thence northwest to fields in northern Lea County, New Mexico.

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# Forty-Year-Old Healdton Is Still a Lively Pool

**One of Oklahoma's early pools is still producing more than 6,000 bbl. daily from 1,990 wells.**

**by John C. McCaslin**

HEALDTON field, western Carter County, Oklahoma, one of the state's early important producing areas, is proving its consistency as a good producer. Though 40 years old this year, Healdton is producing 6,200 bbl. daily.

The field has 1,990 producing wells most of which produce from the Healdton sands of Upper Pennsylvanian age. These sands range in depth between 700 and 1,400 ft. Cumulative production to March 1, 1953, was 218,151,000 bbl. with remaining reserves in the field estimated to be more than 32,000,000 bbl. During 1952 the field produced 2,183,000 bbl. of oil. Total productive area in the field is 7,142 acres. Recovery to date has been nearly 30,000 bbl. per acre or an average of more than 400 bbl. per acre-foot. During the past 10 years the field's production has shown a decline of only 2½ per cent.

Red River Oil Co. opened the field in 1913 with initial production at the first well 80 bbl. daily from a 20-ft. pay sand. The second well in the field came in for 300 bbl. daily. Low drilling costs and the high initial production rates at Healdton aided rapid development of the field during 1914. Low crude prices and lack of markets kept development at a low ebb during late 1914 and in 1915, but by the twenties 11 pipe lines were carrying crude out of the field as far away as Wood River, Ill.

The Carter-Stephens County area of southern Oklahoma, currently the most active in Oklahoma, has long been one of the major producing areas in the state because of such fields as Healdton, Hewitt, Velma, and Sholem Alechem. Operators completed 326 oil and gas wells in Carter County last year, while 515 oil and gas wells were finaled in Stephens County.

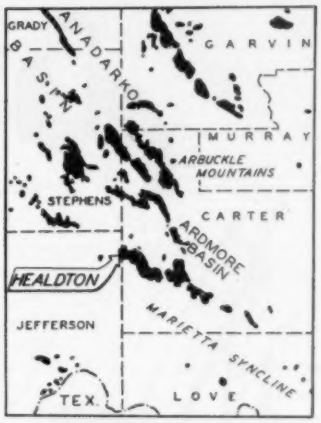
### Regional Geology

Surface formations in Carter County range in age from Ordovician, which outcrops in the Criner Hills, to Cretaceous beds in the Marietta syncline.

A generalized section for Carter County follows:

- Recent
  - Alluvium and gravel
- Cretaceous
  - Goodland limestone
  - Trinity sandstone
- Permian
  - Red beds
- Pennsylvanian
  - Pontotoc series
  - Hoxbar
  - Deese (Healdton sands?)
  - Upper Dornick Hills (Hewitt sands?)
- —Major unconformity—
  - Lower Dornick Hills
  - Springer
- Mississippian
  - Caney shale
  - Sycamore limestone
  - Woodford chert
- —Major unconformity—
- Devonian
  - Hunton
    - Bois d'Arc
    - Haragan shale
- Silurian
  - Hunton
    - Henryhouse shale
    - Chimney Hill limestone
- —Major unconformity—
- Ordovician
  - Sylvan shale
  - Viola limestone
  - Simpson group
  - Arbuckle limestone
- Cambrian
  - Arbuckle limestone
  - Reagan
- Pre-Cambrian
  - Granite

Many of these formations are exposed in the highly folded area southwest of Ardmore, which includes the Criner Hills and the Overbrook anticline. The Permian red beds cover most of the county west of the Indian meridian (between ranges 1e and 1w), including the Healdton area.




**Ardmore basin place-fix map.**

**Drilling practices . . .** Cable tools were used to drill most of Healdton's early wells. Drilling time was 10 to 20 days. Rotary tools were used for drilling into lower pay zones. Most of the recent wells drilled in the field have used a combination of cable and rotary tools with the average drilling depth to productive Healdton sands about 1,200 ft.

A portable rotary rig is used to drill to the top of the oil sand where the production string is set and cemented. A cable-tool rig is then used to drill into the producing sand. This practice is followed because water-base mud might penetrate and seal off the pressure-depleted Healdton oil sands, resulting in poor production or dry wells. Some wells have been completed recently with rotary tools, using oil-base mud.

**Structural history . . .** The structural history of the area began in late Pennsylvanian time following the deposition of the lower Dornick Hills.

Along with the Wichita-Arbuckle-Ouachita diastrophism smaller parallel folds were formed running northwest and southeast. These small folds influenced oil accumulations in Healdton, Velma, Loco, Fox-Graham, Sholem Alechem, and Tatums fields.

In the erosional period following the Arbuckle uplift, Lower Pennsylvanian and older formations were removed from the crest of the Healdton and other major structures. Gradual subsidence followed, advancing from the Marietta syncline and Ardmore basin northwestward. During the early stages of this subsidence and deposition Healdton stood out as an island with steep limestone cliffs facing the sea. Sand bars and shale beds were deposited around the base of Healdton island. As subsidence continued, lentic-

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ular sand and shale beds were deposited on top of Healdton island

Following deposition of the Hoxbar the area was folded and faulted along the former trends and raised above sea level. (In the Healdton area there is little apparent break between the later Pennsylvanian sediments and the overlying Permian red beds, although to the east a disconformity is noted). Gulf seas invaded the continent once more in early Cretaceous time, spreading over Oklahoma and Kansas. In Carter County, a small patch of Cretaceous sediments in the Marietta syncline is all that is left of the Cretaceous sediments deposited by these seas. All of the Cretaceous and much of the Permian sediments have been removed from the Healdton hills by erosion during the present emergence.

### Producing Sands

Most of Healdton's oil comes from the sands of Deese (?) age, and are discontinuous and lenticular.

The sands have been separated into four zones. However, the upper three, because of difficult correlations, are generally treated as a common reservoir. This is practical but does not represent all actual conditions.

The shallowest sand of the upper three is the thickest and the most extensive, but it is now nearly depleted. It should lend itself well to water flooding. The second and third sands are very lenticular, with alternating beds of sand and limestone of high and low permeability. The total productive area of the three upper sands includes 7,016 of the 7,142 productive acres in the field.

**Fourth sand . . .** The fourth Healdton sand is a separate reservoir and differs from the upper sands in that it is under the influence of a definite water drive. This sand is more uniform in character but less extensive, being absent in large areas of the field where the top of the Ordovician surface is structurally high. The original productive area of the fourth sand covered 1,960 acres with total thickness from 50 to 75 ft.

The porosity of the fourth sand is more consistent than that of the upper sands. Average porosities in this sand run between 20.8 and 25.5 per cent.

A study of the producing history of this sand indicates that the actual economically producing area of the sand is less than that within the designated oil-water contact line, particularly at the southeast end of the field. The oil-water contact is not horizontal, but follows the structure so that in an area along the edge of the structure the water level is close to, though not at the top, of the sand zone. Wells drilled

in this area are not economically productive, finding only a thin oil sand above bottom-hole water. The oil-water contact in the fourth sand ranges from about 180 ft. below sea level in the field's north end to 470 ft. below sea level along the southwest flank in the field's southeast extension.

**Oil in place . . .** That portion of the pore spaces not filled with connate water is assumed to have been saturated originally with reservoir oil.

With deductions for connate water and shrinkage taken into consideration, the original oil saturation of the pores in the upper Healdton sands would range from 87.5 per cent of the pore space at 32.0 per cent porosity and 3,000 md. permeability to 36.8 per cent at 12.0 per cent porosity and 18 md. permeability. The estimated stock-tank oil in the reservoir is 674,195,000 bbl.

**Field's future . . .** There are many million of barrels of oil in Healdton field that will not be recovered by the present operating methods. With water injection in properly spaced input wells much of this oil can be flushed from the sands. The water-flood engineer will have many problems facing him with water injection, but the recovery of millions of barrels of oil is possible at Healdton. A report of this possibility is scheduled for an early issue of the Journal.

Much of the material for this article was taken from the February 1953 Bureau of Mines Report of Investigations 4917, Petroleum - Engineering Study of Healdton Oil Field, Carter County, Oklahoma, by C. H. Riggs, John E. Wey, Edward Sanabria, Jr., Paul Meadows, William C. Smith, and James A. West.

## MAPS

Highways 775 and 77. A joint project of the Houston Geological Society and the American Geological Institute. Handled by Dr. Frank J. Gardner, Secretary of the Houston Geological Society, P. O. Box 331, Houston. $1.50.

This is the first in a series of geologic strip maps of Texas highways released by the Houston Geological Society. This initial map covers portions of highways 75 and 77 from Galveston through Houston, Conroe, Corsicana, Dallas, and Denton, to the Texas-Oklahoma line.

These maps reveal to the traveler the names of the geologic formations he is crossing, the oil fields he passes, and other informations of interest along the way. They cover about 4 miles on each side of the highways.

In detail, this map booklet shows location of formation contacts, approximate position of faults, subsurface contours, type localities, and good outcrops along the way. Also shown are data for each county including climatic factors, area, elevation, history, populations, and smaller individual county maps showing oil field locations.

## OKLAHOMA

OKLAHOMA

### Third Pay Zone Proved at McClain County Discovery

Jay Simmons' wildcat east of Blanchard in McClain County, south-central Oklahoma, has proved a third pay zone, the Tulip Creek.

Simmons 1 Ray Wilson, C SE SE 14-8n-4w, flowed oil at the estimated rate of 75 bbl. per hour, proving more oil pay in the rich Tulip Creek sand. A drill-stem test from 10,451-81 ft. flowed gas at the estimated rate of 5,000 to 10,000 M.c.f. per day and 75 bbl. of oil per hour. Recovery was 830 ft. of 46.3°-gravity oil no water. Crews are coring ahead for the Oil Creek.

The Bromide sand flowed 15,000 M.c.f. of gas per day and some distillate spray on a test from 10,111-161 ft. The Hunton lime gave up 2,160 ft. of oil and gas-out mud and 30 ft. of free oil on test.

The new discovery is located 1¼ miles northwest of a recent Bromide sand oil strike in the area, K. A. Ellison's 1 Tankersley, C NE NW 25-8n-4w.

A drill-stem from 10,481-509 ft. in the Tulip Creek sand recovered 1,247 ft. of oil and 180 ft. of gas-cut mud. Crews are coring ahead at 10,551 ft.

### New Pay Reported in Revived Southwest Dover

Activity in rank Kingfisher County, north-central Oklahoma, has picked up with revival at Southwest Dover pool.

Trigg Drilling Co. has a new Misener (Basal Mississippian) gas-distillate discovery

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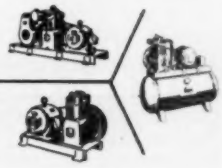

at 1 J. R. Porter, NW NE NE 21-17n-7w. Regular pay in the field is the Simpson dolomite. The well is rated at an estimated 6,000 M.c.f. of gas per day with a good flow of distillate in the Misener at 8,054-66 ft. The amount of distillate is reported to be estimated at 80 bbl. per million feet of gas.

Trigg has staked a north offset spot at 1 Lee Boecher, SE NW SE Section 16. About 11 miles west and 3 miles south of Hennessey Champlin Refining Co. has a gas showing in the basal Pennsylvanian or Upper Mississippian at 1 Wiley, C NW NE 10-18n-8w, promising that Kingfisher County can expect some important new developments in the near future.

**Garfield County . . .** George Deck et al are testing a new pay in Northeast Prairie Valley pool in Garfield County, north of the new development in Kingfisher. The well flowed 20 bbl. per hour in the Marshall sand from perforations at 6,112-27 ft. The Marshall sand is part of the Simpson series. Crews have perforated the Mississippian at 5,482-5,504 ft. and are testing.

## North Gotebo Area Test Has Springer Gas Shows

The North Gotebo area of Kiowa County, southwestern Oklahoma, has an indicated Springer sand gas discovery about 5 miles west of the town of Mountain View.

Huffman & Mallory and Zephyr Drilling Corp. passed a gas show in the Springer sand at 1 Heiple, NW SE NW 6-7n-15w, projected 6,500-ft. test. The indicated strike flowed gas at the estimated rate of 1,000 M.c.f. per day on a drill-stem test from 3,582-3,600 ft. Recovery was 30 ft. of slightly gas-cut mud. Crews are drilling ahead.

## Caddo Pool Revived

Central Carter County's Caddo pool is getting new attention after a recent new pay discovery in the pool and a good flowing Hunton lime well completion late last year.

Beach & Talbot revived the area in October by completing 1-A Lloyd Noble, C SE NE 35-3s-1e. The well flowed 280 bbl. of oil in 24 hours from the Hunton. Bay Petroleum Co. is dually completing 1 Taylor, SE NW SW Section 23, in the Hunton and Springer. The Springer sand is a new pay for the pool. The same company's 1 Pruitt, SW NE SW 23, flowed 200 M.c.f. of gas per day from 2,837-2,900 ft. in the Springer sand and recovered 420 ft. of heavily oil-cut mud.

The 1 Taylor flowed Hunton oil at the rate of 65 bbl. per hour following acid treatment from perforations at 4,277-92 ft. The Springer flowed 135 bbl. of oil per day from 2,784-2,830 ft.

A stepout operation west of the north end production in the field has been started by Signal Oil & Gas Co. at 1 Noble, SW SW NE 22. Beach & Talbot have a well testing in SE SW SE 23, and a well preparing to perforate on the south flank.

# KANSAS

## Larned Pool Has New Extension

Pawnee County, western Kansas, has a new extension at expanding Larned pool, which was revived last year by Musgrove Petroleum Corp. at 1 Phinney, SW SW NE 34-21s-16w.

The old pool, located on the west flank of the Central Kansas uplift, has 15 new wells since that time, and only one dry hole recorded. The new stepout success is Musgrove's 1 Baldwin, NE NE NW 3-22s-16w, ½ mile south of the pool. A drill-stem test from 3,863-78 ft. recovered 3,550 ft. of 42°-gravity oil with a good gas blow.

Recently Westgate-Greenland Oil Co. put on the pump a new discovery 6 miles southeast of Evers pool in Pawnee. The 1 Smith, SE SE SW 22-22s-15w, was swabbed for 150 bbl. of oil in 3 hours from the Arbuckle at 3,960-80 ft. The 1 Smith is located 6 miles northeast of the Benson pool area of eastern Pawnee County, and 8 miles southeast of Larned.

## Important Tests Under Way

The upper end of the Hugoton embayment of the Anadarko basin has an important new wildcat under way.

The remote test is Cooperative Refinery Association and Argo Oil Corp.'s Logan County wildcat, the 1 Schaffer "A," C NE NW 13-12s-33w. The new try is located 16 miles south of Mingo pool and 8 miles southwest of Oakley, Kansas. Operators are drilling below 2,865 ft.

**East-Central . . .** Harvey, McPherson, and Dickinson counties each have one new test under way. J. P. Gaty will drill 1 Golden, NE SE SE 28-24s-2e, wildcat 6 miles southeast of Jester Creek pool in the southeastern corner of Harvey County. Anschutz Drilling Co. has set 8-in. and is waiting on cement at 1 Almstrom, NE NE NW 26-18s-4w, new test 4 miles south of Lindsborg pool and 6 miles northwest of McPherson, Kansas. Dick-


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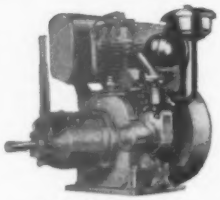

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inson County's new try is Lotus Oil Co.'s 1 Foster, NW SE NE 29-14s-4e. This wildcat is located 11 miles north of North Lost Springs pool.

**Nemaha Ridge . . .** New tests have been reported for the Nemaha granite ridge areas of Butler and Cowley counties.

McNeish and Gralapp will drill 1 Wheeler, SW SW NW 21-32s-3e, 1 miles east of Slick-Carson pool and 6 miles west of Winfield. Salina Drilling Co. is drilling 1 Metz in the SE NW NE 34-34s-5e, 1 mile southeast of Rahn Southwest pool in the southern part of Cowley. Three miles northeast of Potwin pool in the northwestern corner of Butler County, J. H. Wagner is drilling 1 King, NW SE NE 22-24s-4e.

**Southern Kansas . . .** Both Barber and Meade counties have new wildcats staked. Sinclair Oil & Gas Co. will drill 1 Moffett, NE NW NW 9-30s-15w, 2½ miles northwest of Sun City pool and ½ mile north of abandoned Moffett pool in the northwestern corner of Barber, while in the western part of Meade County Columbian Fuel Corp. will drill 1 Meyer, C SW NE 20-33s-30w, 3 miles west of Novinger pool.

**Saline basin . . .** Two new tests are reported in Saline County at the foot of the Saline basin. National Associated Petroleum is drilling below 2,160 ft. at 1 Pistora, SE NW SW 22-13s-5w, 16 miles northwest of Salina pool and ½ mile north of Glendale, Kansas. At the opposite end of the county in southeast Saline Cliff McCown has staked 1 McLin, NE NE SW 32-15s-1w, 1¼ miles north of North Hunter pool.

## MICHIGAN

### Moffatt Wildcat Continues Swabbing In the Dundee

On initial swab-tests natural, after cement plug was drilled out of 5-in. casing, and before well was acidized, the Jack Uhl 1 McFarlan, NE NW SW 34-20n-3e, Moffatt township wildcat, Arenac County, swabbed about 152 bbl. of oil to tanks in 3 days. A small amount of water, not believed to be bottom-hole water, was recovered on this preliminary testing, and the water-cut was reported to be decreasing as swabbing was continued. A total of 12 bbl. of water showed along with the 152 bbl. of oil.

After cement plug was drilled and before well had been cleaned out completely, hole filled 1,600 ft. with oil in 17 hours, and showed about 53 bbl. of oil during first 8 hours of swabbing. The gas, which showed strong on drill-stem test, did not appear in quantity on first tests after casing was cleaned out, but after about three days of swabbing there was evidence of a definite increase in the amount of gas showing. Well was being tubed this week. Some observers were of the opinion that well might flow through the tubing. Plans to acidize, probably with a small clean-up shot, were being formulated.

Uhl's 1 McFarlan, one of the most interesting and important wildcat developments on the Michigan horizon, is being tested in the Dundee at 2,988 ft., total depth. Top of Dundee was logged at 2,911 ft. Best porosity zoned showed in cores at 2,984-88 ft. Although preliminary core analysis was reported to have shown very little, if any dolomite, a more detailed analysis indicated that there was dolomite present in much of the pay section.


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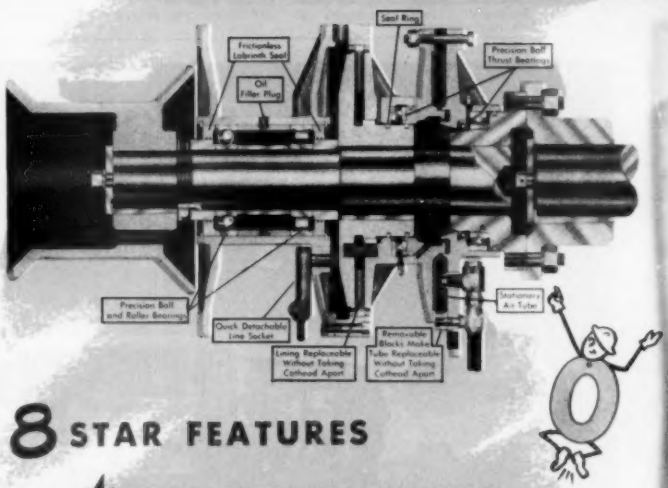
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## ROCKY MOUNTAIN

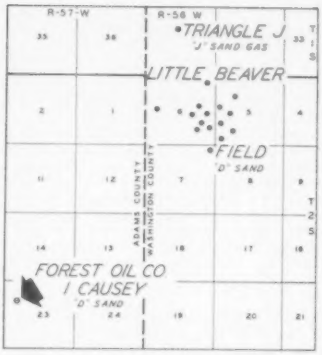
### COLORADO

## Three Discoveries Added To Denver Basin Area

Three discoveries were added by exploration in Colorado, contributing to the excitement already prevalent among Denver-Julesburg basin operators as a result of shows in Permian sands in the Keota area of Weld County which were announced a week ago.

Two of the trio of discoveries were in Logan County, west and southwest of Yenter pool, one of the best producing fields in the basin. The third was an apparently excellent "D" sand discovery 4 miles southwest of Little Beaver field in Adams County which has tapped a new pool which appears similar to the prolific Little Beaver field itself.

Forest Oil Co. has cored a 28-ft. saturated section of friable, porous and permeable "D" sand at 1 Causey, NE SW NW 23-2s-57w, southwest of Little Beaver field. Drill-stem tests through the entire section recovered good quantities of oil, with only the last test from 5,262-72 ft. showing a small quantity of fresh water. At this depth the operator is still in the sand, and is now reported coring ahead. The 28-ft. section is much thicker than the average producing horizon in Denver-Julesburg basin fields. Recovery of 40°-gravity oil from the above interval was 2,480 ft. in 1 hour. From 5,248-62 ft. the recovery was 3,525 ft. of gas-cut oil and 220 ft. of gas and oil-cut water in 2 hours. From 5,241-48 ft. the operator recovered 375 ft. of oil, 160 ft.




New Badger Creek Discovery

of mud-cut oil and 20 ft. of muddy in 2 hours open time. Top of the "D" sand was called at 5,222 ft.

Little Beaver field, where the excellent development of Cretaceous sands has made commonplace the completion of 400-600 bbl. per day producers, is developing into one of the best producing fields in the basin, and is now ranking approximately third among Colorado fields. The area has become one of the most active in the state during recent months.

Two and one-half miles west of Yenter, in Logan County, Don Johnston Drilling Co. and E. M. Craig, Jr. tested gas at the rate of 8,000 M.c.f. per day from 1 Budin, SW SW NW 6-8n-54w. The operators are running casing with total depth at 5,367 ft. Test was of the "J" sand interval 5,359-67 ft.

Ryan Oil et al recovered 375 ft. of light green oil on 1-hour test of "J" sand 5,371-77 ft. at 1 State, NW NW NW 16-8n-54w, about 2 miles southwest of Yenter. This wildcat will drill ahead to Morrison before attempted completion.

Sherrod and Apperson's deep wildcat in the Keota field, Weld County, 8 Gillette, C NW NW 9-9n-61w, recovered apparently commercial quantities of oil from a Permian sand questionable identified as Lyons is drilling below 8,775 ft. with no new shows reported. The operation, however, is a tight hole, with no official information released.

### MONTANA

## West Richey, Montana Wildcat Swabs Oil

Regent Drilling Co. is reported to have swabbed at the rate of 5 bbl. of oil per hour at 1 Schock, SW NE SW 22-23n-49e, McCone County, Montana for a possible discovery west of Richey field. The wildcat is 1½ miles from nearest production. Operator reported the well still cleaning up during the 5 bbl. per hour recovery. Production was from perforations 7,018-26 ft. in the Charles (?). The interval was acidized before tests began. By contrast with Richey field proper, there was no significant recovery of water during swab test.

### NORTH DAKOTA

## Wildcat Test Slated For Billings County

Amerada Petroleum Corp. has made location for its first wildcat outside the immediate Nesson anticline area since discovery of oil in North Dakota. The wildcat is 1 May, C NW NE 9-139n-100w, in Billings County,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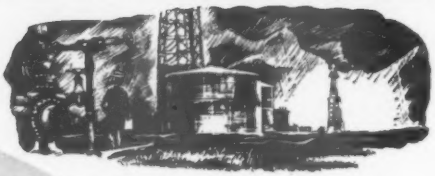

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about 5 miles west of Belfield. The Amerada venture is about 35 miles northwest of 1 Brusich, SE SE SE 8-135n-98w, a deep failure by Stanolind Oil & Gas Co. and Deep Rock Oil Corp. which has encouraging shows in Mississippian horizons, but failed of commercial production. Amerada will test Madison at the wildcat.

### WYOMING

## South Glenrock Area May Be Extended to Southwest

South Glenrock field in Converse County, Wyoming, one of the best postwar discoveries on the south flank of the Powder River basin may be extended to the southwest further toward the basin's edge as a result of tests now being conducted by Far West Oil Co. and Hancock Oil Co. at A-1 VR Ranch, C SE SE 26-33n-76w; the well is about 2½ miles southwest of production in the field, and operators are running casing after recovery of some oil from both Muddy and Dakota zones which are productive in the field proper. The well is bottomed at 6,417 ft. The area southwest of the field has had considerable attention since the South Glenrick and South Big Muddy discoveries in 1950 and 1951, but exploration through the area has been without success to date.

Shell Oil Co. has announced completion of unitization of a 30,463-acre block in the Pine Butte area (14 and 15 North, 98 and 99 West) Sweetwater County, and will drill a well on the block within 6 months. The Green River basin has been active during the past two years with three discoveries made over that time.

# TEXAS

### WEST TEXAS

## Deepened Project Yields Devonian Oil

Exploration of the deeper rocks in West Texas has paid off again in northeast Andrews County; this time at Anderson-Prichard Oil Corp. et al 1-E University. This venture, located some 16 miles northeast of Andrews, in NW NW 7-7-University Lands Survey, recovered oil on its first drill-stem test of the Devonian, and had flowing oil on the second test.

**Background . . .** The well was originally drilled dry to 5,886 ft. in 1949. Present operators are Anderson-Prichard, Continental Oil Co., J. C. Barnes and J. C. Williamson, the latter independent operators at Midland. New contract was to 13,700 ft. as an Ellenburger test. Nearest Devonian production is to the northwest in the Block 6 field, and according to tentative tops, the new well is 137 ft. high on the Devonian to the discovery of the Block 6 pool. Cactus Drilling Corp., San Angelo, has drilling contract.

Top of the Devonian was 12,326 ft. on elevation of 2,994 ft. That top was 246 ft. higher than Continental Oil Co. 1-8 University, dry hole 1½ miles to the south.

First test of the Devonian recovered water blanket and 3,300 ft. of free, 41° oil, from section between 12,335-76 ft. Second test, at 12,355-415 ft. started flowing water blanket in 1 hour and 50 minutes, and clean oil in 2 hours and 15 minutes. Flowing through 5/8-in. bottom-hole choke, it was cleaned into pits, then turned into tanks where it gaged 36.6 bbl. of oil the last hour of the test.

The well caught fire while laying down drill pipe following the test but did not suffer extensive damages. It will be drilled ahead after repairs have been made. Outlook for the Ellenburger was good, based on the high Devonian structure.

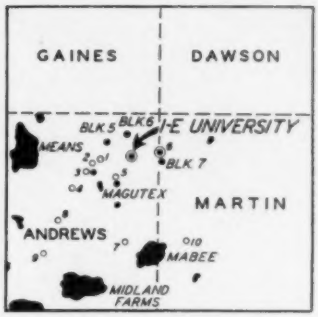
Other wildcat activity in the area of the new discovery, and numbered on the accompanying map, are:

1. Phillips Petroleum Co. 1 University, "TT." Drilling in the lower Permian, on 14,000-ft. contract. Location is 1½-miles northeast extension try to a recent Devonian discovery.

2. Phillips 1 University, "RR." Testing in the Devonian, topped at 12,450 ft., minus 9,399 ft. Location is ½-mile north of Devonian discovery.

3. Phillips 1 University "UU." A 14,000-ft. west extension try, drilling ahead in the Permian.

4. Sharples Oil Corp. 1-A Means, 14,500-ft. wildcat 4 miles west of Magutex, scheduled to

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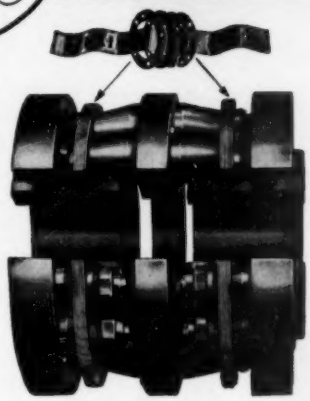

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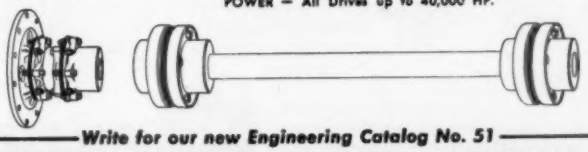

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test the Ellenburger. Operators were drilling ahead at 9,939 ft. after topping the Wolfcamp at 9,920 ft., minus 6,821 ft. On that market it was slightly low to the Magutex discovery.

5. Humble Oil & Refining Co. 1 University, "R," ½-mile north of Hutex field discovery well (Devonian), drilling ahead around 6,000 ft.

6. Jake L. Hamon 1-B University, second Devonian well in the Block 7 field, and 1-mile north extension. Top of the Devonian was 12,220 ft. on elevation of 2,934 ft., 54 ft. high to the Block 7 discovery well. Completed last week for 480 bbl. of oil a day through 16/64-in. choke from pay section at 12,222-44 ft.

7. Magnolia Petroleum Co. 1-BA Fasken, Ellenburger failure and Fusselman discovery 2 miles northwest of shallow production in the Mabee field, completed for 114 bbl. of oil a day through 14/64-in. choke from perforations at 12,818-29 ft. Total depth was 13,560 ft.

8. Continental Oil Co. et al 1 McCollum, new 13,500-ft. test starting, 6 miles southeast of Andrews. Rigging up at last report.

9. Humble 2 University, "O," new 13,500-ft. wildcat north of a Wolfcamp producing area. Drilling ahead at 7,747 ft.

10. Phillips 1-C Scharbauer, 14,000-ft. wildcat ahead at 12,056 ft. This well swabbed 80 bbl. of oil and 15 bbl. of water in 12 hours from perforations in the Spraberry at 8,820-70 ft., and recovered free oil from the Wolfcamp.

EAST TEXAS

## Robertson County Wildcat Is Gas Discovery

Union Producing Co. 1 Gibson, George Robertson Survey, A-38, completed as a gas discovery in the Glen Rose, giving the county its second producing area. Location is 5 miles northeast of Calvert, and about 10 miles northeast of shallow oil production in the Calvert field.

Completion was for 5,000,000 cu. ft. of gas daily from perforations at 6,140-61 ft. Extensive testing was done to 8,053 ft., in the Travis Peak, which had several shows of gas but carried salt water.

Further exploration has been scheduled for Ellis County, one a deep test to the Ellenburger. The latter well is Johnny Mitchell 1 Nora Anderson, in the location state, and in the W. H. H. Bradford Survey, 2 miles northwest of Midlothian.

The shallow test is H. A. Penn 1 Peary Wileman, 4,000-ft. wildcat in the Thomas F. McCrary Survey, near the Maypearl townsite.

Riggings up was under way on a third operation in the newly discovered Fain-Woodbine trend in Cherokee County. C. M. Ashby 2 C. H. Fain was moving in for a 5,200-ft. test, north of the field discovery, in the S. S. Henry Survey, A-958. R. J. Caraway 1 Jones, second test for the new field, was drilling below 4,300 ft.

TEXAS GULF COAST

## South Decker's Prairie Development Spreads

Development in the South Decker's Prairie area of Harris County continues to spread. The area is one of the most active in the upper Texas coastal region. An additional completion and the starting of two more wells were reported the past week.

Latest completion has been by Fidelity Oil & Royalty Co. at its 1 Emil Seidel and others, which flowed 119 bbl. of 39.6°-gravity oil on a 24-hour potential gage through ¼-in. choke with pressures of 610 psi. on the tubing and

725 psi. on the casing. Gas-oil ratio was 500 cu. ft. per barrel. Casing is perforated at 5,333-36 ft.

Location is 660 ft. south of a well completed the previous week by K & H Operating Co. which extended production two-thirds of a mile southward.

New locations have been made by K & H Operating Co. at 2 Bayer, in the John Edwards Survey, and Simonton & Talley at 1 Mitchell, in the C. D. Crenshaw Survey. Both are extension attempts, the latter being the most easterly location for the field. Two other tests are drilling.

## Second Pay Zone Opened In New North Buna Field

The new North Buna field, located about 5 miles northwest of Buna, in Jasper County, got its second producer and a new pay zone the past week with the completion by American Republics Corp. and Houston Oil Co. of their 1 Johnson fee, in the John D. Johnson Survey.

Potential flow of the new well was 46.5 bbl. of fluid in 24 hours through 9/64-in. choke with tubing pressure of 440 psi. and gas-oil ratio of 3,250 cu. ft. per barrel. Fluid was 38.1 bbl. of 46.2°-gravity oil and 8.4 bbl. of water.

Location of the well is 690 ft. south of the discovery well, completed last January by Ada Oil Co. and Hurt Oil Co., Ltd., and which flowed 183 bbl. of 37.8°-gravity oil in 24 hours on through ⅛-in. choke potential gage. Its pay zone, open through casing perforations at 7,572-7,579 ft. is approximately 350 ft. deeper than that of the discovery well.

Ada and Hurt are now drilling at a location (2 Richardson), north of the discovery producer.

# CANADA

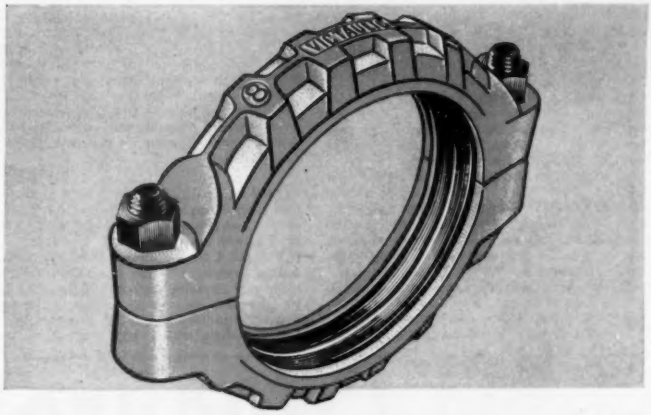
## Four Discoveries Noted In Alberta Areas

Four wildcats in Alberta were chalked up as discoveries of either oil or gas during the week, with the most recent strike being a gasser in the Flatbush area of north central Alberta. The other discoveries include a D3 Devonian reef find in the south Sturgeon Lake area of the northwest, an oil strike in the basal quarts on the Samson Indian Reserve, and another gasser in the Kessler area of east central Alberta.

The Flatbush area gas discovery well has indicated that a sizable gas zone may be present in the Basal Cretaceous sands, and during four drill-stem tests has flowed at rates ranging from 1,085,000 to 2,830,000 cu. ft. daily, with combined flow rate totalling 7,435,000 cu. ft. per day. The gas sand was encountered at 2,774 ft., and 65 ft. of zone, that contains some shale breaks, has so far been cored and tested below that contact.

This new gasser is Great Plains-New British Dominion 16-9 Flatbush, LSD 16, 9-66-1w5, 80 miles north-northwest of Edmonton, and about 2 miles north of an abandoned well.

Initial basal drill-stem test at Flatbush was run from 2,773-88 ft. for 1 hour, and natural gas flowed in 3½ minutes at rate of 1,085,000 cu. ft. daily. Recovery was 5 ft. of gassy mud. Interval 2,788-2,813 ft. flowed gas in 4 minutes, at rate of 1,570,000 cu. ft. per day and gave a recovery of 10 ft. slightly gassy mud. Interval 2,813-25 ft. flowed gas at 1,950,000 cu. ft. daily, while latest test was run from 2,825-39 ft. and flowed gas in 1½ minutes at rate of 2,830,000 cu. ft. Recovery during that 1 hour test was 10 ft. of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heavily oil and gas-cut mud. Coring and testing is being continued. After fully penetrating the gas sand hole will be taken down to test the Devonian objectives.

**Reef strike...** Alberta's northwest D3 reef discovery well was attempting to drill-stem test over the week end, and results of that test, which is bottomed 65 ft. below the D3 contact, should be known early next week.

This discovery, Amerada "R" F 3-19 Crown LSD 5, 19-69-22w5, is 14½ miles south-southeast of the North Sturgeon Lake reef strike that Amerada Petroleum Corp. chalked up last August. As yet it is not definitely known whether the new discovery is on the same structure as the 1952 find, or on a separate coral reef. Two drill-stem tests run at this venture flowed approximate 36°-gravity crude oil to the surface, and assured the company of at least 37 ft. of oil pay zone above the water line, and if water is found at the same level as the northern venture, it should be encountered in the test that is currently under way. Whether or not Sturgeon will develop into a major oil reserve will be determined partially by the outcome of the current testing well, and by additional drilling in the area. Amerada now has two other drillers under way on its extensive Sturgeon Lake holdings.

**Central region ...** Additional news came from the central region of Alberta, as oil discovery was assured at a wildcat being drilled by Western Leaseholds, Ltd. of Calgary and Union Oil Co. of California, on the Samson Indian Reserve, 13 miles due south of Wetaskiwin and 10 miles northeast of Ponoka. This well found a gas cap in the top of the basal quartz formation, appeared to enter an oil column (along with a sizable gas flow), and latest drill-stem test assured the well of commercial oil production.

Most recent drill-stem test at Western-Union 9-11 Samson, LSD 11, 9-44-24w4, was run of the interval 4,819 to 4,824 ft. for 23 minutes. Natural gas flow rate was down to 360,000 cu. ft. daily (from a high of over 4,000,000), and oil flowed to the surface in 20 minutes. When drill pipe was pulled it was found to contain 850 ft. of 28.4°-gravity crude oil, no water. The basal quartz was contacted at 4,970 ft., and at current bottom 4,824 ft., some 8 to 10 ft. of oil zone has been found below the gas cap. Coring is being continued.

**Kessler area...** This week's other natural gas discovery was made near Kessler, in east central Alberta, 45 miles northeast of Calgary and 25 miles east of heavy crude oil wells in the Bulwark area.

The well is being drilled by Sharples Oil (Canada), Ltd., Mill City Petroleum, Ltd., and Kroy Oils, Ltd., on farmout lands from Sweetgrass Oils, Ltd. The well, Mill City-Sharples-Kroy-Sweetgrass 1 Kessler, LSD 13, 27-38-8w4, flowed gas at maximum rate of 4,000,000 cu. ft. daily during drill-stem test of the Viking interval 2,463-2,500 ft. Hole is currently being depened, below 3,220 ft., heading for its Devonian objectives.

### EASTERN CANADA

**Ontario.**—In Huron County, the first test by Imperial Oil, in Colborne township near Holmesville, is drilling below 1,000 ft. A second location is being made. Imperial is conducting a survey in Ashfield township, where it is taking options on Concessions 6 and in the Kingsbridge-Kintail area.

## CALIFORNIA

### New Pool Added Near Santa Fe Springs

Hathaway Co. was in process of completing a new pool discovery about midway in the 3-mile stretch which separates Santa Fe Springs from West Coyote field, on the east edge of Los Angeles. With casing set at 8,792 and cemented through perforations at 6,370 ft., on a short test 1 Woodward flowed at the daily rate of 720 bbl. through perforations at 8,064-8,121 and 8,486-8,686 ft.

The discovery, located in SE NE 11-3-11w, is about ⅓ mile northeast of a marginal well completed by Standard Oil Co. of California in 1946, producing from the Pliocene at 6,880-6,915 ft. It is about ⅞ mile east of The Texas Co. 10-1 McNally Ranch, completed last December in upper Miocene sands stringers between 8,765-8,935 ft. Hathaway 1 Woodward was believed to be producing from the Miocene pays; shows found in the Pliocene had not been tested.

### Guadalupe Extension Failure

Thornbury Drilling Co.'s attempt to extend production in Guadalupe field 1 mile northeast was a failure. Its 1-75 Union Sugar, in 33-11n-35w and 11 miles west of Santa Maria, found water in the Knoxville at 3,086-3,259 ft. (TD) and was abandoned. Productive limits of the southeast-dipping monoclinal structure thus have been established on the northeast, south and southwest.

### Bankline Makes Santiago Find

Bankline Oil Co. made a shallow oil discovery at Santiago Creek, 2 miles east of Santiago field in southwest Kern County. The successful wildcat, 47 Metson in 24-11n-


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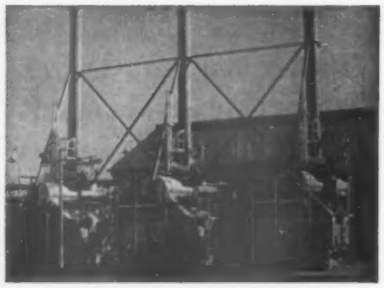

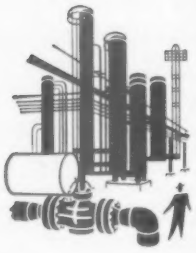

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23w, was producing 11°-gravity crude through perforations at 1,013-1,449 ft. in the Miocene.

A west offset to the discovery, 37 Metson, was immediately started by the operator. This well will be drilled to about 3,500 ft., original objective of 47 Metson before the shallow pay was found.

## Paloma Test Below 17,600 Ft.

The deep test being drilled by Ohio Oil Co., as operator of the Paloma Unit, in that field has passed 17,600 ft. and shortly may become the second deepest test drilled in California. Currently hole is being made at the rate of about 10 ft. daily.

Already the deepest test ever drilled in San Joaquin Valley, if it drills below 17,696 ft. it will be second only to Superior Oil Co.'s. 18,734-ft. test in the Montalvo area near Ventura. The Paloma test, 72-4 K.C.L.A., is seeking production in lower Miocene and Eocene formations and possibly may drill below 20,000 ft.

## Long Beach Area Tests

The Texas Co. in the next month is expected to start a deep test on the 1,100-acre lease it obtained from the City of Long Beach on the municipal airport. The company paid the bonus of $100 per acre required in the bid and agreed to give the city about 40 per cent of any oil developed on the properties. Site of the first of two tests required in the agreement has not been announced but it is expected it will be slanted from a drill-site adjacent to the airport.

Superior Oil Co. and Continental Oil Co. were under way with a wildcat in the Garden Grove area of Orange County, about 10 miles from nearest production. The test, 1 Garden Grove Unit, was being drilled in 28-4s-10w, where the two companies have about 1,000 acres under lease. Scheduled depth of the test is 8,000 ft., or approximately the same as two dry tests in Sections 21 and 33.


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## INDIANA

## Connecting Well Seen For Princeton Pools

A new Aux Vases sand pool was in prospect for Gibson County, due south of Princeton. Details had not been released, but reports credited the well with a 9-ft. saturated section from 2,042-51 ft., plus flowing oil in 26 minutes on drill-stem test.

The prospector is Paco Petroleum Co. et al 1 Bolin Commission, NW SE NE 19-2s-10w. The location is about midway between a small Aux Vases well to the east and slightly south, and the same production in a field southwest of Princeton. Operators were moving in cable tools for completion.

**Illinois development...** Wildcats and extension attempts added three new oil pools last month. These were the North Elliottstown, Effingham County, producing from Cypress sand; North Mills Prairie, Edwards County, producing from lower Ohara limestone, and Melrose in Clark County, producing from a Pennsylvanian sand. One extension well was reported for the Albion Consolidated pool in Edwards County.

New pays discovered included the St. Louis limestone, New Harmony Consolidated pool, White County; McClosky limestone, East Patoka pool, Marion County; Aux Vases sand, East Ellery pool, Edwards County; and the Waltersburg sand in the North Maunie pool, White County.

## ARKANSAS

## Deep Tests Hold Interest

Current interest in exploratory drilling in Arkansas is centered in the East El Dorado area of Union County and in southeastern Miller County.

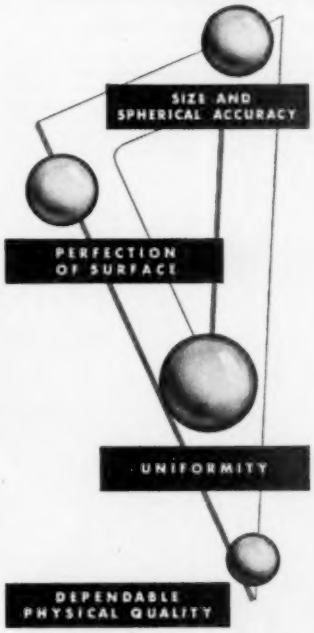
Smackover Production Co. is drilling ahead below 3,374 ft. in the Travis Peak after coring oil sand in the upper part of the formation at 1 LeCroy, 100 ft. south and east of C SW SE 7-17s-14w. The Smackover-bound wildcat is located on the north end of East El Dorado field, Union County. The upper 2 ft. of a core from 2,934-50 ft. was oil sand. The Travis Peak upper sands are productive in Champagnolle field and in the north end of East El Dorado.

In southeastern Miller County in the extreme southwestern part of the state at L Stevens, C SE NE 36-19s-17w, Arkia Oil Co. is bottomed temporarily at 11,090 ft. and has set production pipe. No recovery on a core taken is available.

## East Lisbon Wildcat

Don D. Montgomery is preparing to reperforate sands at 1 Brasher, C SW NE 14-17s-16w, indicated Cotton Valley oil strike 1½ miles east of Lisbon field, Union County. A faulty cement job made it necessary to reperforate at the well. The internal from 4,943-51 ft. gave up 1,800 ft. of 46.6°-gravity oil on a 16-minute test. A second test from 4,951-64 ft. recovered 885 ft. of oil and 25 ft. of formation water.


from any angle

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## LOUISIANA

### SOUTH LOUISIANA

### Major Discovery Indicated For St. Charles Parish

A possible major oil discovery for South Louisiana appears to have been made by Pan American Gas Co. in St. Charles Parish, where its 1 Simoneaux, located in 20-14s-21e, has been completed with a potential flow of 420 bbl. of 38°-gravity oil per day through 12/64-in. choke with tubing pressure of 1,600 psi. Gas-oil ratio is 952 cu. ft. per barrel. Production is from casing perforations at 10,325-38 ft., opposite the base of a sand section logged from 10,280 ft. Hole was drilled to 11,234 ft. and plugged back to 10,476 ft. with casing run to 10,498 ft.

Location is approximately 16 miles southwest of New Orleans and about 6 miles east of the Paradis field, one of the South Louisiana's largest reserves.

### Deep St. Landry Discovery Produces Gas-Condensate

Pre-potential production tests at Stanolind Oil & Gas Co.'s deep discovery well 2 miles east of the Port Barre salt dome field in St. Landry Parish resulted in a flow rate of 321 bbl. of 46.2°-gravity condensate and 2,880,000 cu. ft. of gas per day through 12/64-in. choke. Flowing pressure gaged 5,500 psi. Production is from a sand section, opposite which casing is perforated at 12,269-90 ft. Previous perforations at 13,273-95 ft., where exceptionally high gas pressures were encountered, have been squeezed. Hole had been drilled to 13,659 ft.

### NORTH LOUISIANA

### Bodcaw Condensate Strike Seen for Bossier Parish

A new gas-condensate discovery for northwestern Louisiana's Bossier Parish is apparent at Pan American Production Co.'s 1 L. V. Hunt, Section 5-19n-13w.

Bodcaw sand gas-distillate production was indicated on a drill-stem test from 8,317-42 ft. The 10½-ft. Bodcaw section was topped at 8,313 ft. Recovery was 360 ft. of heavily gas-cut water cushion, 180 ft. of heavily gas-cut mud and a small amount of condensate.

The indicated discovery is located 1¾ miles southeast of Benton, 3¾ miles northeast of Sentell field's northernmost producer, and 5⅝ miles southwest of the nearest production in Benton field. Benton and Sentell fields also produce from the Bodcaw of the Cotton Valley.

**New Redland test . . .** A new Travis Peak test has been announced by Continental Oil Co. in Redland field of northern Bossier. Redland was opened last year as a Travis Peak gas-condensate producer. The new test is located ½ mile east of the Redland field discovery well.

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## APPALACHIAN AREA

### PENNSYLVANIA

In Unity Township, Westmoreland County, southwestern Pennsylvania, Peoples Natural Gas Co. 4003 Dotterway wildcat resulted in a dry hole. Total depth was 8,901 ft. Two previous completions in this area resulted in successful gas wells with high rock pressure. At the present time two are still drilling by the same company.

### OHIO

Leonard Blood et al drilled a well along side of a dry hole in Perry Township, Coshocton County, and Hydrofraced a small show of oil and gas, which resulted in an 890,000 cu. ft. gas well. The Clinton sand in the well, 4 Howard Wilt, Section 6, was logged at 3,091-3,139 ft.

In Mt. Zion field, Mid East 3 Gabriella Dalmasso, Section 25, Jackson Township, Knox County, an outside location, made a good showing of oil natural and 115 bbl. in 24 hours after a 150-qt. shot. Sand was found at 2,842-92 ft. A mile to the north Ulmer & Keithlay 6 Clarence Ashcraft, Section 17, was reported as having sand at 2,872-2,926 ft. with a good oil showing. The test was shot with 140 qt. and made 115 bbl. in the first 24 hours.

## KENTUCKY

### EASTERN KENTUCKY

In the Pike County sector of Big Sandy gas field United Fuel Gas Co. have a dual completion at their 6980 G. C. Rowe. 246,000 cu. ft. of gas daily was gaged from the Maxon (Mississippian) sand from 2,415 to 2,460 ft. while the Devonian black shale made 73,000 cu. ft. Total open flow was 319,000 cu. ft. The shale section was shot with 5,650 lbs. of gelatin.

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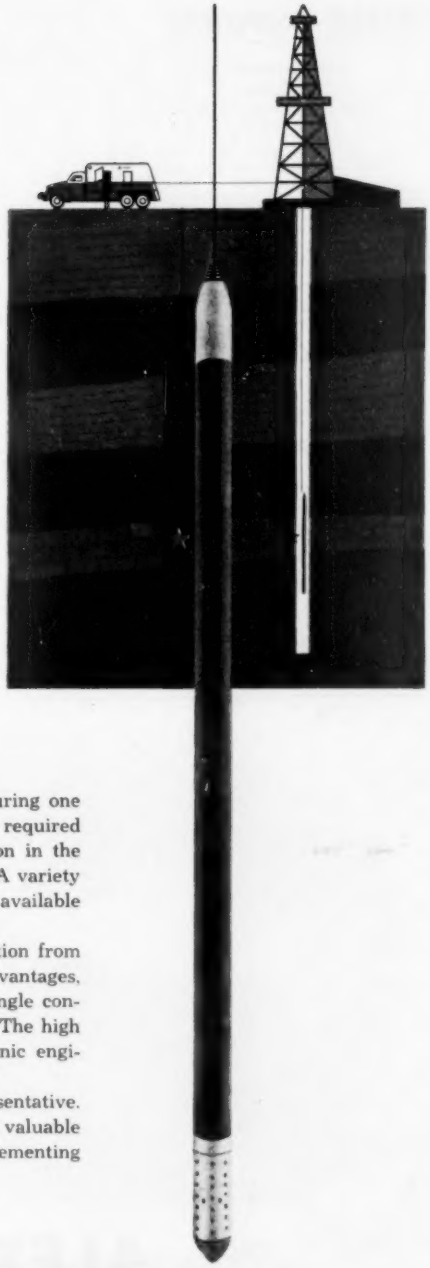

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## WILDCAT COMPLETIONS

### SOUTHWEST TEXAS

Aransas County: Emory M. Spencer and George W. Graham 1 Ingersoll, C. B. Lucas Subd., Buerto Bay Lands, John Smith Sur. Dry. TD 8,515 ft.

Sun Oil Co. 1-368-A St. Charles State, Tract 368, Subd. of St. Charles Bay. Dry. TD 10,492 ft.

Atascosa County: George W. Delker 1 McNutt, Lot 20, Natascosa Colony Farm Tract Subd. Dry. TD 910 ft.

Bastrop County: Olive Boger, trustee, 1 Hinton, Antonio Navarro Sur. Dry. TD 2,050 ft.

Caldwell County: Pat H. Baker et al 1 Fee, M. G. Dikes Sur. Dry. TD 2,465 ft.

Duval County: A. P. Simons 1 Palacios, M. Segura Sur. 61. Dry. TD 5,503 ft.

Frio County: Paisano Trading Co., Ltd., 1 Berry, T. C. Calk Sur. 167. Dry. TD 3,590 ft.

Gonzales County: Producers Corp. of Nevada 1 Johnston, W. T. Williams Sur., A-482. IPP 55 POBD, 24°, perforations 1,960-65 ft. TD 2,020 ft. New field.

Guadalupe County: W. F. Dolgener 1 Elam, George Allen Survey. Dry. TD 860 ft.

Jim Wells County: H. R. Smith 2 Nina Adams estate, Los Presenos Grant. IP 16,500 M.c.f. daily (open flow), perforations 3,402-14 ft. TD 5,490 ft. Extends North Magnolia City field.

LaSalle County: G. B. and T. D. Parr 1 Fee, J. M. Dobie Sur. 284, A-1736. Dry. TD 4,600 ft.

Milam County: Goodpasture & Skaggs 1 Barton, Sarah Wilhem Sur. A-69. Dry. TD 720 ft.

J. J. Rebold 1 Nelson, Josh Leal Sur. Dry. TD 1,230 ft.

Wintex Petroleum Co., Ltd., 1 Kosel, W. S. Nelson Sur., Lots 18-19. Dry. TD 2,740 ft.

Travis County: Fritz W. Bollman, Jr., 1 Dillingham, N. M. Blair Sur. Dry. TD 1,314 ft.

H. F. Goff 1 Gardner, Joe A. Ybarbo Sur. A-421. Dry. TD 730 ft.

E. R. Marts 1 Huebner, Phillip McElroy Sur. Dry. TD 750 ft.

E. R. Marts 1 Platt Brothers Reuben Hornsby Sur. 17. Dry. TD 525 ft.

Travis Production Co. 1 Rosanky, J. S. Montgomery Sur. Shutdown. TD 1,500 ft.

Webb County: T. J. Ahern 1-A William Hubberd, L. Garcia Sur. Porcion 21. Dry. TD 2,623 ft.

W. F. Houser 1 Martin trustee, Borregas Grant, Cabezon Pasture. Dry. TD 1,650 ft.

Dallas Husky et al 1 Raul de La Garza, Blk. 10, Sur. 675, A-1983 ft. Dry. TD 2,585 ft.

Williamson County: A. K. Polis 1 Fierichs estate, Peter Cartwright Sur. A-540. Dry. TD 1,464 ft.

A. C. Schram 1 Eiben, Thomas A. Moore Sur. Dry. TD 1,120 ft.

Theodore Brinkmeyer and S. M. Messer 2 Dabney & Bass, Hamilton White Sur. Dry. TD 1,050 ft.

Martin B. Semands 1 Ging, P. J. Wyche Sur. IPP 2 BOPD, open hole 728-35 ft. TD 735 ft. New field.

Zapata County: A. M. Lacy and H. E. Walton 2 Toribio Garza, San Antonio de Mira Flores Grant. Dry. TD 3,131 ft.

Zavala County: Gar-Woolley Co. 1 Partners, Thomas Toby Sur. 284, A-606. Dry. TD 6,320 ft. in Georgetown lime, top 6,270 ft. Buda 5,880 ft., Del Rio 6,040 ft.

### TEXAS GULF COAST

Bee County: Dallas Husky 1 Hartman et al, G. O'Docharty Sur. IP 13,500 M.c.f. daily (open flow), perforations 4,500-04 ft. TD 4,521 ft. New field.

Brazoria County: E. Cockrell, Jr., 3 M. B. Chilton et al, Austin & Williams Sur., A-145 Stratton Ridge areas. Dry. TD 2,536 ft.

Harry L. Edwards Drilling Co. 1 T. L. Smith estate, C. R. Patton Sur., A-357, Damon Mound area. Dry. TD 2,136 ft.

Calhoun County: Alcoa Mining Co. 1 State, Tract 173, San Antonio River Bay. IP 14,500 M.c.f. daily, perforations 1,657-59 ft. TD 4,026 ft. Extends Steamboat Pass field.

Humble Oil & Refining Co. 1 State, Tract 73, Matagorda Bay. IP 8,000 M.c.f. (open flow), perforations 8,570-90 ft. TD 9,650 ft. New field.

Quintana Petroleum Corp. 1 State, Tract 7, Chocolate Bay. Dry. TD 9,210 ft.

Western Natural Gas Co. and Salt Dome Production Co. 1 State, Tract D, offshore. IP 3,312 M.c.f. daily, ⅛-in., perforations 6,490-6,600 ft. TD 7,005 ft. New field.

Chambers County: The Texas Co. 1 State, Tract 290, Galveston Bay. Dry. TD 10,891 ft.

Colorado County: Fidelity Oil & Royalty Co. 1 Hoyo, GH & H Survey, A-240. IP 21,300 M.c.f. daily (open flow), perforations 9,588-98 ft., 9,604-22 ft., and 9,636-91 ft. TD 11,556 ft. Extends Lizzie West field.

De Witt County: Warren Petroleum Corp. 1 Freidrichs, P. Quinn Sur., A-396. Dry. TD 9,015 ft.

Fayette County: Fidelity Oil & Royalty Co. 1

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Wagenhoff et al, S. A. Pugh League, A-85. Dry. TD 9,325 ft.

Grimes County: John W. Anderson 1 Zarsky, S. F. Austin Survey, A-73. Dry. TD 4,021 ft.

Olive Boger, trustee, 1 Joyner, Dudley L. White Sur. Dry. TD 7,926 ft.

Jackson County: H. H. Howell 1 Kennedy, Narcisco Rodriquez Sur., A-66. Dry. TD 5,140 ft.

Jasper County: J. M. Flaitz and R. B. Mitchell 1 Nantz, J. R. Saulsbury Sur. Dry. TD 8,310 ft.

Jefferson County: Meredith, Clegg & Hunt 1 Nona Mills, Silas Meador Sur., A-180. Dry. TD 10,185 ft.

Karnes County: H. H. Howell 1 Stanik Moy, Luis Menchaca Sur. Dry. TD 3,512 ft.

Lavaca County: Devon-Leduc Oils, Inc., and U. M. Harrison 1 Fitzhenry, William John Sur., A-262. Dry. TD 8,115 ft.

Lee County: M. F. Satterwhite 1 Lawrence, W. M. Lewis Sur. Dry. TD 3,568 ft.

Liberty County: The Texas Co. 1 Blanding, William Swail Sur., A-112. Dry. TD 9,018 ft.

Refugio County: Fred W. Shield et al 1 Hynes, Isabell O'Brien Sur. Shutdown. TD 4,703 ft.

Wharton County: Tidewater Associated Oil Co. 1 Boettcher, John F. Stevenson Sur., A-415. IP 2,127 M.c.f. daily, ¼-in., Yegua 7,554-80 ft. TD 8,019 ft. New field.

### EAST TEXAS

*Cherokee County: C. M. Ashby 1 C. H. Fain, S. S. Henry Sur., A-958. IP 79 BOPD, 10/64-in., 32°, Woodbine 5,123 ft. TD 5,173 ft. Discovery 2 mi. NE abandoned Rusk field.

Falls County: W. A. Brian 1 D. G. Wooten, J. Powell Sur. Dry. TD 2,176 ft.

Houston County: Ben W. Hearne 1 C. P. Meador, Jacob Prewitt Sur., A-66. Dry. TD 6,520 ft.

Rains County: Alton Coats 1 Lona McGowan, James Danley Sur., A-59. Dry. TD 4,950 ft.

### WEST CENTRAL TEXAS

Callahan County: John H. Wilson 1 C. B. Snyder, Sec. 142, BBB&C Sur. Dry. TD 2,917 ft. Morris 2,590 ft.

John J. Eisner 1 B. B. Nunley, Sec. 280, G. W. Sloan Sur. Dry. TD 2,957 ft., elev. 1,825 ft., Caddo 2,845 ft.

Coleman County: Ultra Oil Co. 1 Morris, Sec. 751, A. West Sur. Dry. TD 3,300 ft.

*Horace White 5 C. B. Moseley, Sec. 40, HT&B Sur. IP 288 BOPD, 11/64-in., 44°, said pay 2,987 ft. TD 2,996 ft.

Comanche County: L. A. McDoball 1 J. H. Burton, Lampasas CSL. Dry. TD 1,983 ft., elev. 1,498 ft., Ellenburger 1,973 ft.

*Eastland County: Don H. Peaker 1 E. A. Ivey, 39-4-H&TC. IP 50 BOPD, 16/64-in., 40°, pay 1,704-09 ft., TD 1,730 ft.

Sojourner Drilling Co. 1 J. W. Brown, 19-1-BBB&C. Dry. TD 3,200 ft.

Jones County: B. Baldridge 3 Barsosh, Sec. 23, D&DAL Sur. Dry. TD 2,152 ft.

Sid Katz 1 Walter Pope, Sec. 93, BBB&C Sur. Dry. TD 3,318 ft., elev. 1,648 ft., King sand 2,856 ft.

*Onyx Oil Co. et al 2 J. H. Doty, Sec. 42, OAL Sur. IP not reported, oil sand 1,907 ft., TD 1,916 ft.

Onyx Oil Co. 1 N. F. Wright, Sec. 42, Orphan Asylum Lands. Dry. TD 1,941 ft.

Roark, Hooker, Hill and Perini 1 Williamson, 26-19-T&P. Dry. TD 5,519 ft.

Sojourner Drilling Co. 1 M. R. Whittemore, 39-1-BBB&C. Dry. TD 3,976 ft.

Yeatman Drilling Co. 1 Mrs. Gene Pittard, Sec. 12, OAL Sur. Dry. TD 4,605 ft., elev. 1,660 ft., Palo Pinto 4,022 ft.

Shackelford County: W. H. Green 1 Alice Walker, 71-13-T&P. Dry. TD 2,009 ft.

Kilroy Co. of Texas 1 W. H. Green, 69-12-T&P. Dry. TD 1,104 ft.

Oil & Gas Incomes, Inc., 1 C. J. Jones, Sec. 1260, TE&L Sur. Dry. TD 3,224 ft., Caddo 3,202 ft.

### NORTH TEXAS

Archer County: Delhi Oil Co. and R. W. Darden 1 J. S. Davis, E. Waieischouski Sur., A-675. Dry. TD 1,172 ft.

Luke Grace Drilling Co. 1 C. Mankins, Blk. 2, SPRR Sur., A-944. Dry. TD 4,412 ft.

Baylor County: Tres Oil Co. 1-C E. W. Hunt, Blk. 29, J. Garner Sur. Dry. TD 1,585 ft.

Clay County: N. G. Landrum 1 R. L. Denson-Faulkner, S. M. Herron Sur., A-199. Dry. TD 4,400 ft.

Cooke County: A. D. Britton 1 G. A. McCorkle, J. C. McElroy Sur., A-711. Dry. TD 5,010 ft.

Kay Kimbell 1 J. W. Woods, E. Spencer Sur., A-922. Dry. TD 5,257 ft.

Sussex Oil Co. 2 J. A. Dennison, Z. Whitesides Sur., A-1091. Dry. TD 1,600 ft.

Taubert & Harper 1 Frank Mitchell, J. English Sur., A-345. Dry. TD 3,003 ft.

Jack County: G. E. Kadane & Sons 1 F. F. Dixon, C. Vanderver Sur., A-868. Dry. TD 5,207 ft.

Montague County: George S. Engle 1 Oscar Lanier, MEP&P Sur., A-531. Dry. TD 5,185 ft.

Luke Grace Drilling Co. and Rock Island Refining Co. 1 M. Fowler, Blk. 29, H&TC Sur., A-365. Dry. TD 5,910 ft. Caddo 5,635 ft.

Reno Oil Co. 2 Lee Crenshaw, W. Wallace Sur., A-834. Dry. TD 5,747 ft. Conglomerate 5,722 ft.

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The "Puritan Story" should be read . . . and re-read, and told often! It is the story of the "Communal System" of government under which the Puritans lived for two years, and which failed miserably, leaving misery and many deaths in its wake. It was the result of this experience that prompted the governors — who were not politicians — to decide that the "Free Enterprise System" should prevail and, by their action, this system was adopted. Its success has been peculiarly American, and through it we have become the freest and the greatest nation on earth . . . the envy of mankind everywhere. Read it! Talk it! Tell it often! It should never be allowed to be forgotten!

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The Prosser-Type Swivel Rope Socket is typical of the many ruggedly efficient Spang Cable Tools that are known and preferred throughout the world.

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## CEMENTROL SHOE

Provides an annular packoff and an internal bridge that prevent downward passage of slurry and subsequent contamination of exposed formation below casing seat.

Cementrol Shoe Running-in Position

Cementrol Shoe in Pack-Off Position

## CEMENTROL COLLAR

Operates just as Cementrol Shoe to direct slurry upwardly above perforated liners, formation crevices or other zones of lost circulation located at any point above casing seat.

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Cementrol Equipment is hydraulically actuated by pump pressure. The Flapper Type Collar allows passage of bridging ball used in this operation.

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Flapper-type Collar Pumping Through

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## WILDCAT COMPLETIONS

* Wichita County: Cox Drilling Co. 1 Kemp & Kempner, Blk. 82, KWVFL Sur. IPP 18 BOPD, 39°, sand 3,907-14 3,912-22 ft. TD 4,014 ft.
* Henry Grace Production Co. 9 Neva R. Temple, Blk. 13, Cowherd Bros. Subd., Palo Pinto CSL. IPP 19.5 BOPD, 40°, sand 1,267-69, 1,275-78 ft. TD 1,297 ft.
* Harry F. Snebold 1 Julius Michna, 6-A193-Wm. Mayer Sur. IP 101 BO 8 hours, 21/64-in. 43°, pay 4,258-4,314 ft. TD 4,314 ft.

S & S Drilling Co. 1 Myrtle Ashbrook, Blk. 5, Denton CSL. Dry. TD 557 ft.

Wilbarger County: Milton Fishet 1-B Waggoner, Sec. 1, H&GN. Dry. TD 2,000 ft.

Young County: J. G. Duvall 1 S. M. Gose, TE&L Sur. 65, Blk. 313. Dry. TD 1,022 ft.

H. D. Egger 1 J. D. Baty, J. M. Baker Sur., A-1669. Dry. TD 4,154 ft.

R. F. Hunter 1-B Holcomb, J. Garrett Sur., A-107. Dry. TD 4,514 ft. Caddo 3,944 ft.

* A. F. Knappenberger and Bay Petroleum Co. 1-A Calvin, A. Rohus Sur., A-240. IP 174 BOPD, 17/64-in., 40°, pay 1,917 ft. TD 1,929 ft.

Lindsey & Howard 1 H. C. McKinney, TE&L Sur. 1367. Dry. TD 960 ft.

Panhandle Oil Corp. 1 C. Hoard, Sec. 177, TE&L Sur. Dry. TD 1,024 ft.

### WEST TEXAS

* Cochran County: L. T. N. Drilling Co. 1 Grollman, 4-L-PSL. IP 118 BOPD, 31°, pay 5,052 ft., TD 5,078 ft. Extension to Landon field.

J. D. Wrather 1 Culp-Hobby, 10-Z-PSL. Dry. TD 11,920 ft., elev. 3,898 ft., Mississippian 11,390 ft., Devonian 11,871 ft.

J. D. Wrather 1 Stella Thompson, 12-Z-PSL. Dry. TD 560 ft.

* Dawson County: Seaboard Oil Co. 1 R. M. King, 2-35-T6N-T&P. IPP 22 BOPD, 33°, San Andres 3,875-4,340 ft., TD 8,960 ft. Discovery.

Pecos County: George T. Abell 2 Sloan-Blair, 35-10-H&TC. Dry. TD 2,259 ft.

Reagan County: Clifton Thomas and R. S. Anderson 1 Texas Pacific Land Trust, 203-1-T&P. Dry. TD 2,885 ft.

Scurry County: Ned C. Butler 1 John E. Brown, 113-3-H&GN. Dry. TD 1,903 ft.

Tom Green County: Blackwood & Nichols 1-A Seals, 1-D-G&NORR. Dry. TD 5,094 ft., elev. 1,731 ft., Ellenburger 4,900 ft.

### SOUTHEAST NEW MEXICO

*Lea County: Skelly Oil Co. 1-S Mexico, 23-12s-52e. IP 533 BOPD, 15/64-in., 44°, Wolfcamp 8,810-70 ft., TD 8,696 ft. S extension to East Caprock, second Wolfcamp well in field.

Western Natural Gas Co. 1 Jacobs-State, 19-16s-37e. Dry. TD 12,871 ft. Strawn 11,170 ft., Devonian 12,752 ft., Mississippian 11,837 ft., Woodford 12,612 ft., elev. 3,837 ft.

### NORTHERN NEW MEXICO

Rio Arriba County: Douglas Kenaston 1 Kenaston, E½ NW NE 10-26n-1e. Dry. TD 1,427 ft. Morrison 1,273 ft.

### ILLINOIS

Clark County: E. Connelly 1 Hardway, SE NE NE 6-9n-13w. Dry. TD 570 ft.

Clinton County: T. M. Pruiett 1 Peters, NE SE SW 16-2n-3w. Dry. TD 1,075 ft.

Washington County: Nash Redwine 1 Silger, SW SW NE 31-1n-1w. Dry. TD 1,700 ft.

### INDIANA

Knox County: V. R. Gallagher 1 Jackson, SW SW SE 5-1n-11w. Dry. TD 2,188 ft. McClosky 2,090 ft.

Vanderburgh County: R. Halbert 1 Wassmer, SE SE NW 19-4s-11w. Dry. TD 2,249 ft., Cypress 2,237 ft.

### WESTERN KENTUCKY

Muhlenberg County: Westfall-Sargent 1 Lear, NE NW SW 6-G-29. Dry. TD 296 ft. Westfall-Sargent 1 Sweeney, SW SW NE 6-G-29. Dry. TD 1,086 ft.

Logan County: F. W. Rowe 1 Chawdoin, SW NW SE 3-D-30. Dry. TD 1,802 ft., elev. 631 ft., Ordovician 1,728 ft.

Ohio County: Stanolind Oil & Gas Co. 1 Barnard, SW NW NE 7-L-31. Dry. TD 1,573 ft.

### EASTERN KENTUCKY

Bell County: North American Petroleum Co. 1 Viall, Stoney Fork. IP 700 M.c.f., Big lime (Mississippian) 2,757-2,784 ft. TD 2,784 ft. (New pool.)

### MICHIGAN

Gratoit County: I. W. Hartman 1 Cary, SE SE SE 10-11n-4w. Dry. TD 2,883 ft. in Traverse lime.

Jackson County: Collins Oil Co. 1 Hungerford et ux, NW SW NW 35-3s-3w. Dry. TD 1,595 ft. in Traverse lime.

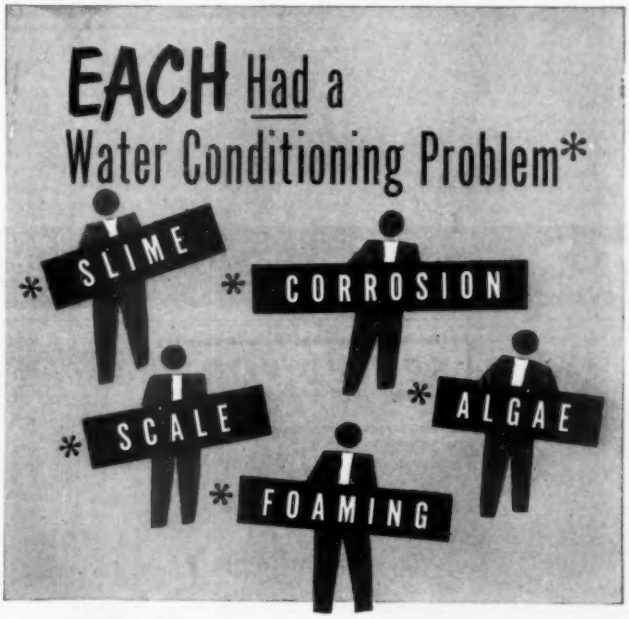
Jackson County: Michigan Oil & Gas Drilling Co. 1 Crum, NE SW NW 17-4s-1w. Dry. TD 1,644 ft. in Traverse lime.

### OHIO

Muskingum County: Frank Lyons et al 1 Max Carrothers, Sec. 14, Monroe Township. Dry. TD 3,236 ft. in lime.

### PENNSYLVANIA

Elk County: Bennetts Valley Development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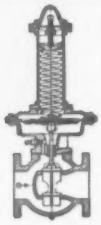

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## WILDCAT COMPLETIONS

Co. 1 Woodring, Benezette Quadrangle Section F, 6,200 ft. E of W line, 2,500 ft. N of S line. IP 800 M.c.f. daily, Oriskany sand 6,154 ft. TD 6,154 ft.

Westmoreland County: Peoples Natural Gas Co. 4003 Dotterway, Unity Township. Dry. TD 8,901 ft. Chert 8,300 ft.

### WEST VIRGINIA

In Center District, Gilmer County, Olsen L. Warren completed 1 Park Norman gaging 2,425 M.c.f. of gas per day from the Big lime. Total depth was 1,475 ft. A number of wells have been recently drilled in this area, but is by far the best one yet.

### MARYLAND

Garrett County: Eberly & Snee 1 Ross Lichty. Dry. TD 4,177 ft. Oriskany sand 4,050 ft.

### FLORIDA

Santa Rosa County: The California Co. 1 Santa Maria unit, C SE NW 33-6n-26w. Dry. TD 6,043 ft. in lower Cretaceous. Elev. 253 ft., Chalk 3,170 ft., first Eutaw 4,636 ft., Massice 5,768 ft., lower Cretaceous 5,964 ft.

### SOUTH LOUISIANA

Cameron County: Coltexo Corp. 1 Sweet Lake, NE NE NE 4-12s-7w (West Chalkley area). Dry. TD 9,614 ft.

The Texas Co. 1 State-Mallard Bay, 3,743 ft. from NL and 4,268 ft. from EL Township 13s-3w, in Mallard Bay. Dry. TD 9,845 ft.

Iberia Parish: Magnolia Petroleum Co. 3-C State Lease 843, Blk 45, Eugene Island, in Gulf of Mexico. IP 595 BOPD, 13/64-in., 37.3°, casing perforations 10,290-96 ft. TD 11,008 ft. New pay in Eugene Island Block 45 field.

Samedan Oil Corp. 1 Jeanerette, 10-12s-10e. Dry. TD 12,700 ft.

Iberville Parish: Humble Oil & Refining Co. 2-C Wilbert, 77-8s-8e. IP 395 BOPD, 10/64-in., 36.4°, perforations 11,031-68 ft. TD 11,081 ft. New pay in Bayou Des Glaise field.

### NORTH LOUISIANA

Winn Parish: W. J. Thomas et al 1 Capps, C SW SW SW 35-10n-1w. Dry. TD 1,610 ft.

### ARKANSAS

Ouachita County: C. G. Davis et al 1 Allen, C NW SE 20-15s-17w. Dry. TD 3,800 ft.

Phillips County: Oil & Gas Development Associates 1 Racebrook, 6-4s-2e. Dry. TD 4,270 ft.

### OKLAHOMA

*Beaver County: Carter Oil Co. 1 Tretbar, C NW NE 7-5n-22eCM. IP 4,896 M.c.f. gas daily, Morrow 6,315-30, 236 M.c.f. Chester 6,526-54 ft. TD 7,043 ft. (New pool).

Comanche County: Headington Bros. 1 Grimes, SW NE NE 17-1s-10w. Dry. TD 2,500 ft.

W. H. Atkinson et al 1 Ingram, SW NW NW NE 28-4n-11w. Dry. TD 1,703 ft.

Logan County: Russell Maguire, Continental Oil Co. and Fleet Drilling Co. 1 Dodson, SE SE NW 17-17n-1e. Dry. TD 5,179 ft.

Eason Oil Co. 1 Biggs, NE NE SW 27-16n-2w. Dry. TD 6,122 ft.

McVay and Stafford Drilling Co. 2 Seibolt, NE NE SW 15-19n-2w. Dry. TD 5,588 ft.

Love County: The Texas Co. 1 Conrad, SW SE NW 17-7s-3e. Dry. TD 4,277 ft. Sylvan 4,242 ft.

McCurtain County: Shirley et al 1 Tiddle, NW NW NE NW 8-8s-23e. Dry. TD 507 ft. Cretaceous 397 ft.

*Osage County: Kewanee Oil Co. and Glenn Gillispie 1 Osage, SE SE SE 29-25n-7e. IPP 17 BOPD, Skinner 2,553-60 ft., Burbank 2,591-2,660 ft. TD 2,827 ft. (Burbank sand extension and Skinner zone discovery at Northwest Naval Reserve pool).

Pottawatomie County: Ned Biffle et al 1 Edwards, NE SW NW 6-7n-2e. Dry. TD 6,212 ft.

Stephens County: Cities Service Oil Co. 1 Tilghman, NW SE SW 12-1n-1w. Dry. TD 4,832 ft.

### KANSAS

*Barber County: Coppinger 1 Herndon, NE NE SW 36-30s-12w. IPP 28 BOPD, Mississippian 4,296-4,311 ft. TD 4,796 ft. (Opens Amber Creek pool).

Musgrove Petroleum 1 Dickerson, NE NE NE 24-31s-15w. Dry. TD 4,840 ft.

Barton County: Shelley-Miller 1 Menzer, SE SE NW 15-17s-15w. Dry. TD 3,581 ft.

Butler County: E. F. Wakefield 1 Wilson, NE NE SW 17-27s-4e. Dry. TD 2,765 ft.

Cowley County: Gross Drilling Co. 1 Berrie, SE SW NW 24-33s-3e. Dry. TD 3,338 ft.

Ellis County: Okmar 2 Gasaway, NE SE NW 11-11s-19w. Dry. TD 3,645 ft.

Cook & Galloway 1 Jensen, NW NW SW 35-11s-19w. Dry. TD 3,746 ft.

Trans-Era 1 Dreiling "C," SE SE SW 24-12s-20w. Dry. TD 3,975 ft.

Ellsworth County: Lewis Drilling Co., Derby


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THE OIL AND GAS JOURNAL

**"Well, now we know it ain't a cow—let's not waste any more time on this fool thing."**

## WILDCAT COMPLETIONS

Oil Co. 1 Mollhagen, SW SW NW 20-17s-8w. Dry. TD 3,380 ft.

*Pawnee County: Armer 1 Ellis, SE SE NE 9-20s-19w. IPP 651 BOPD, Sooy 4,204-20 ft. TD 4,224 ft. (New pool).

Tom-A-Hawk Petroleum 1 Schartz, NW NW NE 8-23s-16w. Dry. TD 4,300 ft.

*Rooks County: Champling Refining 4 Brungardt, NW SE SE 35-10s-17w. IPP 114 BOPD, Sooy 3,449-70 ft. TD 3,566 ft. (New pay in Brungardt pool).

Sedgwick County: J. P. Gaty 1 Hurst, CEL SE NE 4-28s-2e. Dry. TD 3,080 ft.

Kewanee Oil Co. 1 Roy, SW SW NE 13-29s-1w. Dry. TD 3,355 ft.

Stafford County: Petroleum, Inc., 1 Miller, NW SE SW 6-23s-13w. Dry. TD 3,948 ft.

*Trego County: Imperial 1 Spaulding "B, NW NW NE 1-11s-21w. IPP 17 BOPD, Lansing-Kansas City 3,573-80 ft. TD 3,727 ft. (New pool).

### NEBRASKA

Cheyenne County: Chicago Corp. and Republic Natural Gas Co. 1 Lena Overholt, NE SE SW 21-14n-50w. Dry. TD 4,861 ft, "J" sand.

Kimball County: Stanolind Oil & Gas Co. 1 Harley Long, S½ N½ SW NE 25-13n-55w. Dry. TD 6,539 ft. Dakota 6,482 ft.

* Anderson-Prichard, Rogers & Wheeler 1 State, NW NW NW 36-15n-56w. IPP 90 BOPD, "J" sand 6,336 ft. TD 6,400 ft. (New pool.)

### CALIFORNIA

Fresno County: Lebow-McNee Oil Co. 1 Miller & Lux, 31-11s-14e. Dry. TD 7,510 ft.

* Kern County: Murvale Oil Co. 555 Murvale-Tidewater 26 B, NE SE 26-31s-23e. IP 334 BOPD, 14/64-in., 36.6°, perforations at 3,795-5,088 ft. TD 5,023 ft. (One mile southeast extension to Buena Vista Hills Antelope shale pool.)

* Richfield Oil Corp. 41-28 San Emidio A, NE NW 28-11n-22w. IPP 129 BOPD, 16.2°, perforations at 7,148-7,196 ft. TD 7,207 ft. (One-half mile southeast extension to Los Lobos field.)

The Texas Co. 1 Edison Securities (NCT-2), 27-30s-29e. Dry. TD 4,530 ft.

Richfield Oil Corp. 1 Tracy, 20-29s-29e. Dry. 5,689 ft.

G. H. Beasley 1 Trans-Cass, 24-20s-22e. Dry. TD 8,200 ft., in Eocene.

* Los Angeles County: Standard - Trousdale & Sterling 45 Villa, NE SW 35-5n-17w. IP 874 BOPD, 20/64-in., 30.5°, perforations at 6,330-6,385 ft. TD 6,550 ft. (One-half mile west extension or new fault block pool in Castaic Hills area of Honor Ranch field.)

* Union Oil Co. 1 Lindauer, NE SE 32-2s-10w. IPP 76 BOPD, 23.2°, perforations at 4,235-4,855 ft. TD 7,334 ft., redrilled TD 6,019 ft. (One mile northeast extension to Brea field.)

The Texas Co. 1 Newhall B, 11-4n-17w. Dry. TD 8,079 ft.

Madera County: Tide Water Associated Oil Co. 1-17 Redman-Stone, 17-10s-14e. Dry. TD 2,968 ft.

San Benito County: E. Nepple 1 Bacon, 13-16s-7e. Dry. TD 5,140 ft. Monroe-Baer Oil Co. 1 "Well, 8-17s-11e. Dry. TD 600 ft.

San Diego County: Grober & Associates 1 Estes, 21-12s-4w. Dry. TD 1,240 ft. in basement.

San Luis Obispo County: Oceanic Oil Co. 1 Phelps-Loukonen, 12-32s-22e. Dry. TD 3,857 ft.

Thornbury Drilling Co. 1-75 Union Sugar, 33-11n-35w. Dry. TD 3,259 ft.

Santa Barbara County: General Petroleum Corp. 14-4 Clayton, 4-9n-24w. Dry. TD 7,259 ft.

### MONTANA

Dawson County: Empire State 1 Hathaway, C SE NE 6-14n-55e. Dry. TD 9,351 ft. Red River 8,870 ft.

Toole County: Dominion Montana Corp., Ltd., 1 Gauss, NW NW SE 5-37n-2w. Dry. TD 2,650 ft. Madison 2,445 ft.

### WYOMING

Converse County: Continental Oil Co. 2 Tribal, SE SE NE 36-6n-2w (WRM). Dry. TD 649 ft. Chugwater 275 ft.

Fremont County: Sinclair Oil & Gas Co. 1 Unit, SE SE NE 22-33n-90w. Dry. TD 3,418 ft. Tensleep 3,409 ft.

### UTAH

Uintah County: General Petroleum Corp., Stanolind Oil & Gas Co. 1 Unit, NW NW SW 2-11s-23e. Dry. TD 8,036 ft. Mancos 7,435 ft.

### COLORADO

Adams County: Havenstrite Oil Co. 1 Leasure, NE SE NW 18-2s-59w. Dry. TD 6,555 ft. Morrison 6,543 ft.

Hiawatha Oil & Gas and Penn Ohio 1-25 Government, C SW SW 25-7n-81w. Dry. TD 8,244 ft. fresh granite 8,243 ft.

M. E. Davis (Benedum Trees) 1 State, C NW NW 36-7n-81w. Dry. TD 6,920 ft. Frontier 6,882 ft. Temporarily abandoned.

Kit Carson County: McDannald Oil Co. 1 Willy, SW SW SW 6-7s-46w. Dry. TD 6,134 ft.

W. R. Rowland and Lee Swedlund 1 Brett & Stafford, SE SE SW 26-12n-55w. Dry. TD 5,993 ft. "J" sand 5,762 ft.


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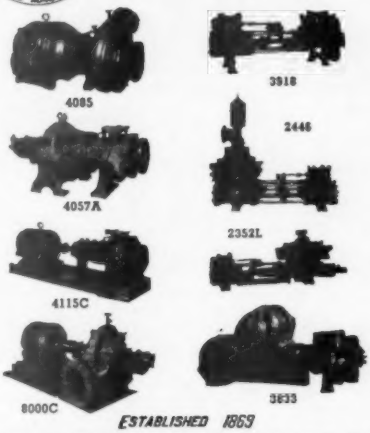


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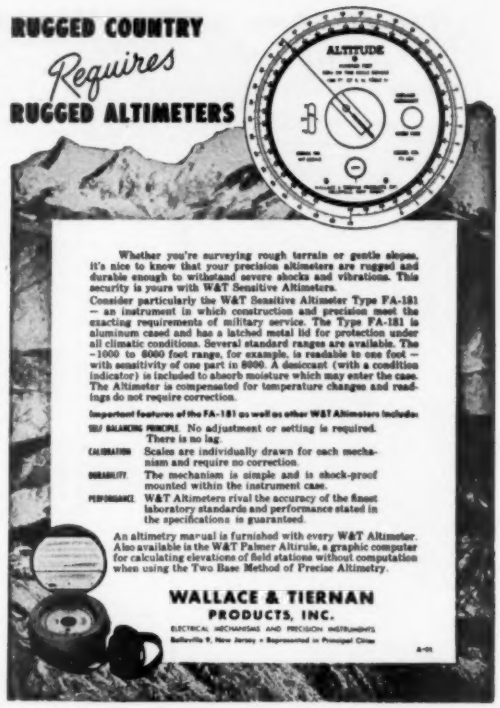


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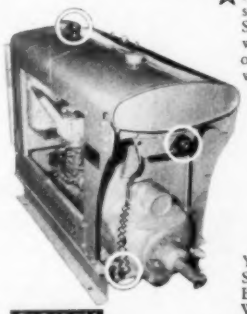

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## WILDCAT COMPLETIONS

Madison County: Lion Investment Oil Co., C. Anderson, C. NW. NW. 10-7n-4w, Dry, TD 3,812 ft., formation 3,808 ft.

Washington County: Hermann Drilling Co., C. Anderson, SE. NW. NE. 21-6n-5w, Dry, TD 4,440 ft., Camerina 4,429 ft.

S. D. Ashmore, Inc., Anderson, SE. NW. NE. 21-6n-5w, Dry, TD 3,847 ft.

### SASKATCHEWAN

[illegible] Canada, LSD. [illegible], Dry, TD 3,404 ft.

[illegible] Lloyd, LSD. [illegible], Dry, TD 3,298 ft.

[illegible] Tate, Whitlash, LSD. [illegible], Dry, TD 3,410 ft.

### ALBERTA

[illegible] Leduc, LSD. [illegible], Dry, TD 4,870 ft.

[illegible] Leduc, LSD. [illegible], Gas well, TD 4,870 ft.

[illegible] Leduc, LSD. [illegible], Gas well, TD 4,870 ft.

[illegible] Springbank, LSD. [illegible], Gas well, TD 4,887 ft.

[illegible] Bowmanton, LSD. [illegible], Dry, TD 2,877 ft.

[illegible] Empress, LSD. [illegible], Dry, TD 4,865 ft.

[illegible] Eagle Butte, LSD. [illegible], Dry, TD 4,865 ft.

[illegible] Eagle Butte, LSD. [illegible], Dry, TD 4,865 ft.

[illegible] Lawrence, LSD. [illegible], Dry, TD 4,892 ft.

[illegible] Hays Lake, LSD. [illegible], Dry, TD 4,292 ft.

[illegible] Medicine Hat, LSD. [illegible], Dry, TD 1,865 ft.

[illegible] Wetmore, LSD. [illegible], Dry, TD 1,865 ft.

## Frio Wildcat Produces

Discovery of a new producing area in Frio County, southwestern Texas, appears to have been made by Howell & Mauer, Inc. and associates (Oil and Gas Journal, [illegible]). The well, Kemper, located 4 miles northeast of Pearsall, in the S. M. Maverick Survey, has been pumped on the pump and has been making about 40 bbl. of oil with approximately 80 bbl. of water per day. Water shut-off is necessary. Pay is in upper part of 1,750-ft. sand. The operators have test, Kemper, located 300 ft. to the southwest and drilled to 5,207 ft., was dry.

## Another Black Warrior Wildcat Gets Gas Shows

Promising gas showings have been encountered in Carter Oil Co. et al. J. McFadden, C. NW. SE. 29-16n-5e, in Clay County, northeastern Mississippi. The possible new field indicated marks another in the succession of gas discoveries which have been made during the past year in the Black Warrior basin of northeastern Mississippi and northwestern Alabama.

The showings were obtained in a 75-minute drill-stem test of an interval at 5,860-56 ft. The test through 3-in. bottom and 34-in. top choke got a good blow at the start with gas at the surface within 47 minutes after the tool was opened. Flowing pressure ranged from 210 to 237 psi. at the top. Shut-in pressure built up to 3,850 psi. Recovery when pipe was pulled was 300 ft. of gas-cut mud. Prospective pay is in the

"They don't profit much in the oil trade."

Mississippi, topped at 7,800 ft. (—7,661 ft.). Rate will be reported for further tests.

## Damon Gets Deeper Pay

Deeper production is being opened in the north area of the Damon Mound oil field in Brazoria County, Texas (Oil and Gas Journal, [illegible]). Stanolind Oil & Gas Co. et al. Damon Mound Unit No. 17, which is on a 640-acre drilling unit, pumped on a 4-hr. test through casing perforations at 4,830-40 ft. The well flowed 1,626 bbl. of 26-gravity oil on 24-hour through 9-64-in. choke on an open-hole gas pressure was 421 psi. on the tubing, and 580 psi. on the casing. Limited rate was [illegible] per barrel.

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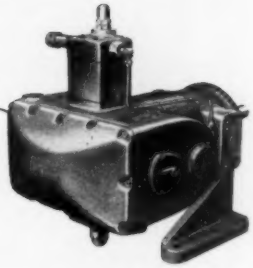

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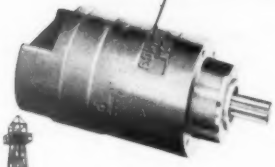

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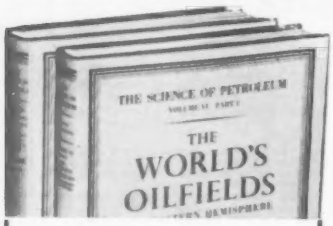


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Washington County: Herndon Drilling Co. 1 Alishouse, SE NW NE 33-1s-51w. Dry. TD 4,485 ft. Cloverly 4,479 ft.

S. D. Johnson, Somers & Dunn 1 State, SE SE NW 18-1s-56w. Dry. TD 5,685 ft. "J" sand.

**SASKATCHEWAN**

Tide Water-Cloverly 1 Crown, LSD 1, 18-7-19w3. Dry. TD 5,404 ft.

Saskoil 2 Leader, LSD 7, 24-21-26w3. Dry. TD 3,230 ft.

Shell-Rio Tinto 1 Whitkow, LSD 4, 30-46-13w3. Dry. TD 3,411 ft.

**ALBERTA**

Royalite-Anglo 1 Eyremore, LSD 4, 21-18-18w4. Indicated oil well from Three Forks. TD 5,440 ft.

Leo 1, LSD 7, 11-47-5w4. Colony oil well, TD 1,870 ft.

Seaboard-Gulf 1 Samson Lake, LSD 1, 20-43-22w4. D3 Devonian oil well. TD 5,381 ft.

Shell-Imperial 1 Springburn, LSD 14, 34-80-17w5. D3 Devonian oil well. TD 6,877 ft.

Winter 1 Brownvale, LSD 13, 19-81-25w5. Dry. TD 7,677 ft.

Trans Empire 21 Campbell, LSD 15, 16-54-25w4. Dry. TD 4,802 ft.

Canamerican 1 Eagle Butte, LSD 7, 15-7-4w4. Dry. TD 3,800 ft.

Royalite 2 Eagle Butte, LSD 7, 32-8-4w4. Dry. TD 4,560 ft.

Bay 1-14 Lawrence, LSD 1, 14-31-15w4. Dry. TD 4,792 ft.

Sun 4-5 Haig Lake, LSD 4, 5-106-4w6. Dry. TD 4,252 ft.

Baysel 7-19 Medicine Hat, LSD 7, 19-14-6w6. Dry. TD 1,442 ft.

Gulf 1 Webiskaw, LSD 7, 13-82-22w4. Dry. TD 3,000 ft.

## Frio Wildcat Produces

Discovery of a new producing area in Frio County, southwestern Texas, appears to have been made by Howeth & Mason. The indicated discovery well, 2 Kemper, located 6 miles northeast of Pearsall, in the S. M. Moss Survey, has been placed on the pump and has been making about 40 bbl. of net oil with approximately 80 bbl. of water per day. Water yield is decreasing. Pay is in open hole at 3,726½-41 ft. The operators' first test, 1 Kemper, located 300 ft. to the southwest, and drilled to 5,217 ft., was dry.

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## Damon Gets Deeper Pay

Deeper production is being opened on the north flank of the Damon Mound salt dome in Brazoria County, Texas Gulf Coast, with the completion by W. Stewart Boyle of his 1 T. L. Smith et al in a sand open through casing perforations at 4,430-46 ft. The well flowed 114.94 bbl. of 26°-gravity oil in 24 hours through 9/64-in. choke on its completion gage. Pressures were 425 psi. on the tubing and 590 psi. on the casing. Gas-oil ratio was 330 cu. ft. per barrel.

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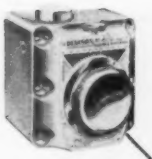

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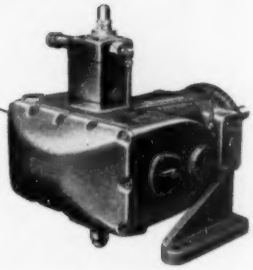

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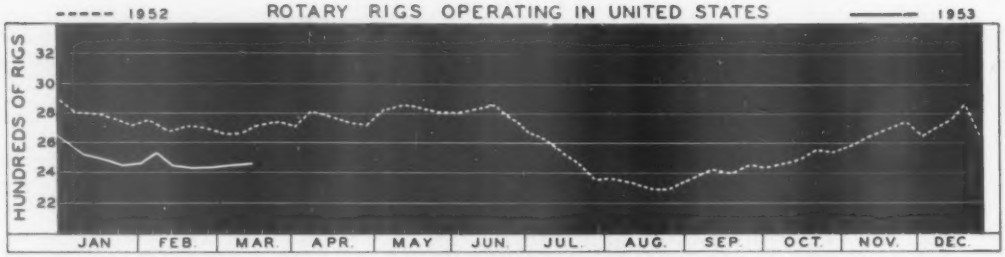
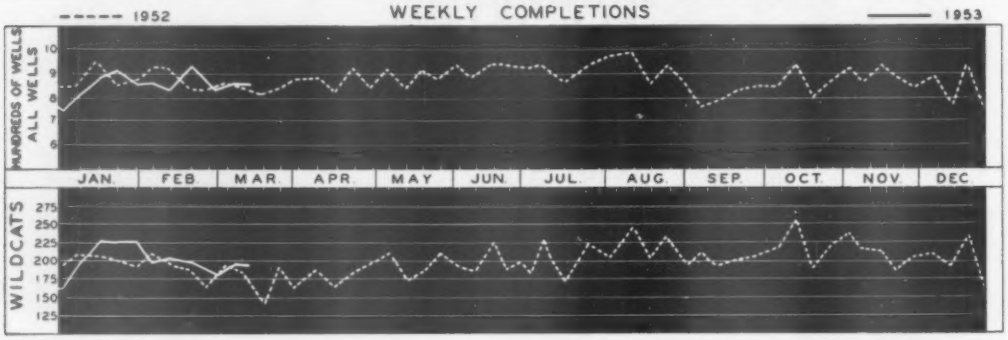


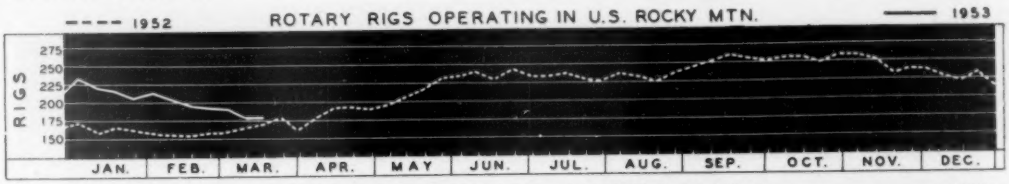

# CURRENT STATISTICS

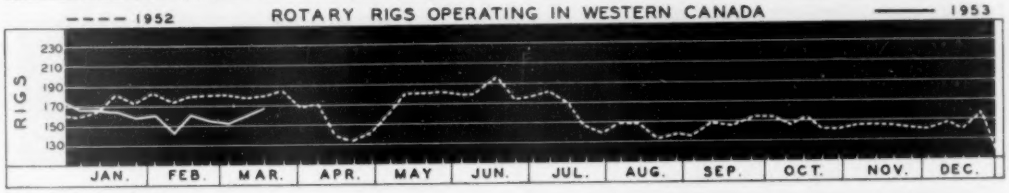
## EXPLORATION

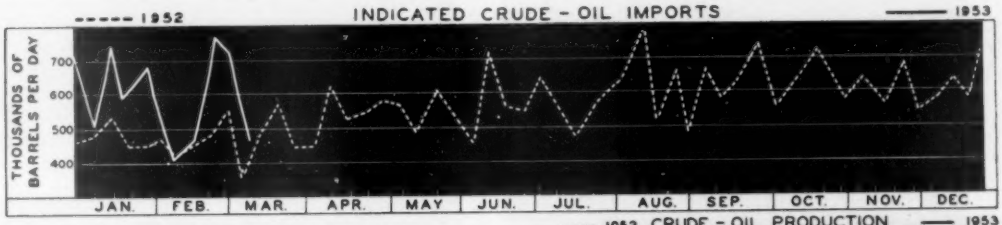
### WEEKLY WELL COMPLETIONS . . . WEEK ENDED MARCH 14, 1953

| | Total of all wells | | | | | Mar. 14 | | Wildcat completions and discoveries | | | | | Cumulative total, 1953 | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Comp. | Oil | Gas | Dry | Footage | 1953 | 1952 | Oil | Dist. | Gas | Dry | Total | Oil | Dist. | Gas | Dry | Total |
| New York | 11 | 5 | 0 | *6 | 15,700 | 126 | 132 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Pennsylvania | 29 | 13 | 3 | †13 | 40,802 | 321 | 317 | 0 | 0 | 1 | 1 | 2 | 0 | 0 | 3 | 6 | 9 |
| West Virginia | 10 | 1 | 7 | 2 | 29,658 | 105 | 128 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 2 |
| Ohio | 23 | 9 | 5 | ‡9 | 58,158 | 187 | 194 | 0 | 0 | 0 | 1 | 1 | 1 | 0 | 0 | 4 | 5 |
| Indiana | 11 | 6 | 0 | 5 | 19,643 | 239 | 211 | 0 | 0 | 0 | 2 | 2 | 5 | 0 | 1 | 55 | 61 |
| Kentucky | 17 | 5 | 4 | 8 | 34,848 | 198 | 256 | 0 | 0 | 1 | 4 | 5 | 4 | 0 | 2 | 37 | 43 |
| Illinois | 22 | 13 | 0 | 9 | 45,833 | 373 | 319 | 0 | 0 | 0 | 3 | 3 | 1 | 0 | 0 | 70 | 71 |
| Michigan | 9 | 4 | 0 | 5 | 20,066 | 118 | 114 | 0 | 0 | 0 | 3 | 3 | 6 | 0 | 1 | 44 | 51 |
| Kansas | 93 | 49 | 9 | ‡35 | 313,089 | 906 | 979 | 4 | 0 | 0 | 12 | 16 | 24 | 0 | 8 | 148 | 180 |
| Nebraska | 7 | 5 | 0 | 2 | 40,475 | 55 | 48 | 1 | 0 | 0 | 2 | 3 | 5 | 0 | 0 | 22 | 27 |
| Oklahoma | 128 | 71 | 3 | 54 | 460,091 | 1,326 | 1,264 | 1 | 0 | 1 | 9 | 11 | 14 | 3 | 6 | 122 | 145 |
| Texas | 337 | 158 | 43 | 136 | 1,555,792 | 3,222 | 3,702 | 12 | 0 | 7 | 82 | 101 | 178 | 16 | 37 | 803 | 1,034 |
| North Central (Dist. 7-B & 9) | 104 | 54 | 0 | 50 | 317,277 | 1,123 | 1,181 | 7 | 0 | 0 | 33 | 40 | 93 | 0 | 4 | 334 | 431 |
| West (Dist. 7-C & 8) | 48 | 34 | 0 | 14 | 255,888 | 701 | 1,155 | 2 | 0 | 0 | 6 | 8 | 31 | 1 | 1 | 121 | 154 |
| Panhandle (Dist. 10) | 8 | 6 | 0 | 2 | 30,916 | 151 | 143 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 6 | 8 |
| Eastern (Dist. 5 & 6) | 21 | 10 | 3 | 8 | 102,067 | 152 | 164 | 1 | 0 | 0 | 3 | 4 | 5 | 0 | 0 | 50 | 55 |
| Gulf Coast (Dist. 2 & 3) | 70 | 24 | 23 | 23 | 467,055 | 498 | 543 | 0 | 0 | 6 | 16 | 22 | 26 | 3 | 17 | 116 | 162 |
| Southwest (Dist. 1 & 4) | 86 | 30 | 17 | 39 | 382,589 | 597 | 516 | 2 | 0 | 1 | 24 | 27 | 23 | 10 | 15 | 176 | 224 |
| Louisiana | 40 | 22 | 4 | 14 | 291,578 | 511 | 463 | 2 | 0 | 0 | 4 | 6 | 12 | 1 | 5 | 65 | 83 |
| Northern | 17 | 10 | 2 | 5 | 80,829 | 222 | 252 | 0 | 0 | 0 | 1 | 1 | 1 | 0 | 0 | 26 | 27 |
| Southern | 23 | 12 | 2 | 9 | 210,749 | 289 | 211 | 2 | 0 | 0 | 3 | 5 | 11 | 1 | 5 | 39 | 56 |
| Arkansas | 8 | 4 | 0 | 4 | 30,367 | 87 | 74 | 0 | 0 | 0 | 2 | 2 | 4 | 0 | 0 | 18 | 22 |
| Mississippi | 1 | 0 | 0 | 1 | 6,242 | 71 | 94 | 0 | 0 | 0 | 0 | 0 | 5 | 0 | 0 | 33 | 38 |
| Southeastern States | 2 | 0 | 0 | 2 | 11,554 | 31 | 10 | 0 | 0 | 0 | 2 | 2 | 1 | 0 | 0 | 24 | 25 |
| Montana | 6 | 2 | 0 | 4 | 31,619 | 80 | 33 | 0 | 0 | 0 | 2 | 2 | 1 | 0 | 0 | 22 | 23 |
| Wyoming | 10 | 7 | 0 | 3 | 23,082 | 112 | 115 | 0 | 0 | 0 | 2 | 2 | 1 | 0 | 0 | 27 | 28 |
| Colorado | 10 | 1 | 0 | 9 | 58,251 | 98 | 87 | 0 | 0 | 0 | 8 | 8 | 2 | 0 | 1 | 58 | 61 |
| Utah | 1 | 0 | 0 | 1 | 8,036 | 17 | 17 | 0 | 0 | 0 | 1 | 1 | 1 | 0 | 0 | 12 | 13 |
| New Mexico | 26 | 12 | 8 | 6 | 147,746 | 249 | 189 | 1 | 0 | 0 | 2 | 3 | 5 | 0 | 4 | 32 | 41 |
| California | 58 | 43 | 1 | 14 | 251,372 | 498 | 523 | 4 | 0 | 0 | 13 | 17 | 12 | 0 | 2 | 115 | 129 |
| North Dakota | 2 | 2 | 0 | 0 | 16,962 | 48 | 4 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 12 | 12 |
| Miscellaneous (Md.) | 1 | 0 | 0 | 1 | 4,177 | 9 | 14 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 7 | 7 |
| Total United States | 862 | 432 | 87 | 343 | 3,515,141 | 8,987 | 9,287 | 25 | 0 | 10 | 156 | 191 | 282 | 20 | 71 | 1,737 | 2,110 |
| Total previous week | 865 | 451 | 75 | 339 | 3,560,131 | | | 28 | 0 | 9 | 159 | 196 | 257 | 20 | 61 | 1,581 | 1,919 |
| Total March 15, 1952 | 815 | 463 | 75 | 277 | 3,391,250 | | | 26 | 0 | 5 | 106 | 137 | 290 | 18 | 50 | 1,646 | 2,004 |

Service wells included: *6, †11, ‡1.



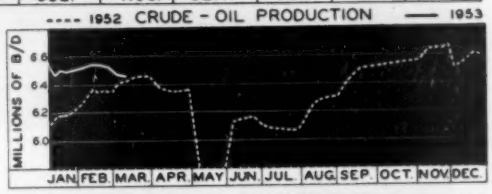



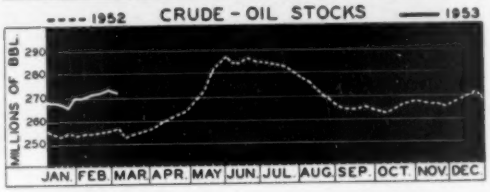




## DAILY AVERAGE PRODUCTION FOR WEEK

| | March 14 | | | Mar. 7 |
|---|---|---|---|---|
| | Crude oil | Lease condensate | Total | total |
| Alabama | 4,300 | | 4,300 | 4,200 |
| Arkansas | 78,250 | 700 | 78,950 | 78,600 |
| California | 991,700 | | 991,700 | 988,600 |
| Colorado | 83,800 | | 83,800 | 87,800 |
| Eastern | 56,000 | | 56,000 | 56,000 |
| Florida | 1,475 | | 1,475 | 1,475 |
| Illinois | 161,300 | | 161,300 | 172,200 |
| Indiana | 34,000 | | 34,000 | 34,400 |
| Kansas | 319,700 | | 319,700 | 320,000 |
| Kentucky | 29,600 | | 29,600 | 29,900 |
| Louisiana | 686,975 | 42,250 | 729,225 | 730,475 |
| North | 113,650 | 2,750 | 116,400 | 117,650 |
| South | 573,325 | 39,500 | 612,825 | 612,825 |
| Michigan | 35,600 | | 35,600 | 35,700 |
| Mississippi | 91,900 | 5,000 | 96,900 | 96,600 |
| Montana | 29,500 | | 29,500 | 29,700 |
| Nebraska | 12,700 | | 12,700 | 12,300 |
| New Mexico | 180,475 | 600 | 181,075 | 180,975 |
| Oklahoma | 542,400 | | 542,400 | 545,300 |
| Texas | 2,790,800 | 50,425 | 2,841,225 | 2,841,225 |
| Dist. 1 | 36,800 | 250 | 37,050 | 37,050 |
| Dist. 2 | 151,675 | 6,000 | 157,675 | 157,675 |
| Dist. 3 | 459,075 | 25,700 | 484,775 | 484,775 |
| Dist. 4 | 254,275 | 6,000 | 260,275 | 260,275 |
| Dist. 5 | 48,500 | 500 | 49,000 | 49,000 |
| Dist. 6 | 122,725 | 6,000 | 128,725 | 128,725 |
| East Texas field | 247,000 | | 247,000 | 247,000 |
| Dist. 7-B | 104,950 | 100 | 105,050 | 105,050 |
| Dist. 7-C | 173,750 | 4,800 | 178,550 | 178,550 |
| Dist. 8 | 931,325 | 350 | 931,675 | 931,675 |
| Dist. 9 | 188,000 | 700 | 188,700 | 188,700 |
| Dist. 10 | 72,725 | 25 | 72,750 | 72,750 |
| Utah | 5,200 | | 5,200 | 5,100 |
| Wyoming | 205,000 | | 205,000 | 204,200 |
| North Dakota | 12,000 | | 12,000 | 11,600 |
| Total U. S. | 6,352,675 | 98,975 | 6,451,650 | 6,466,350 |
| Change from previous week, down | | | 14,700 | |
| Canada | 145,000 | | 145,000 | 144,950 |
| Total U. S. production January 1-March 14 | | | 475,125,250 bbl. | |
| Same period last year (crude plus cond.) | | | *466,755,825 bbl. | |

*Includes 7,072,135 bbl. condensate.



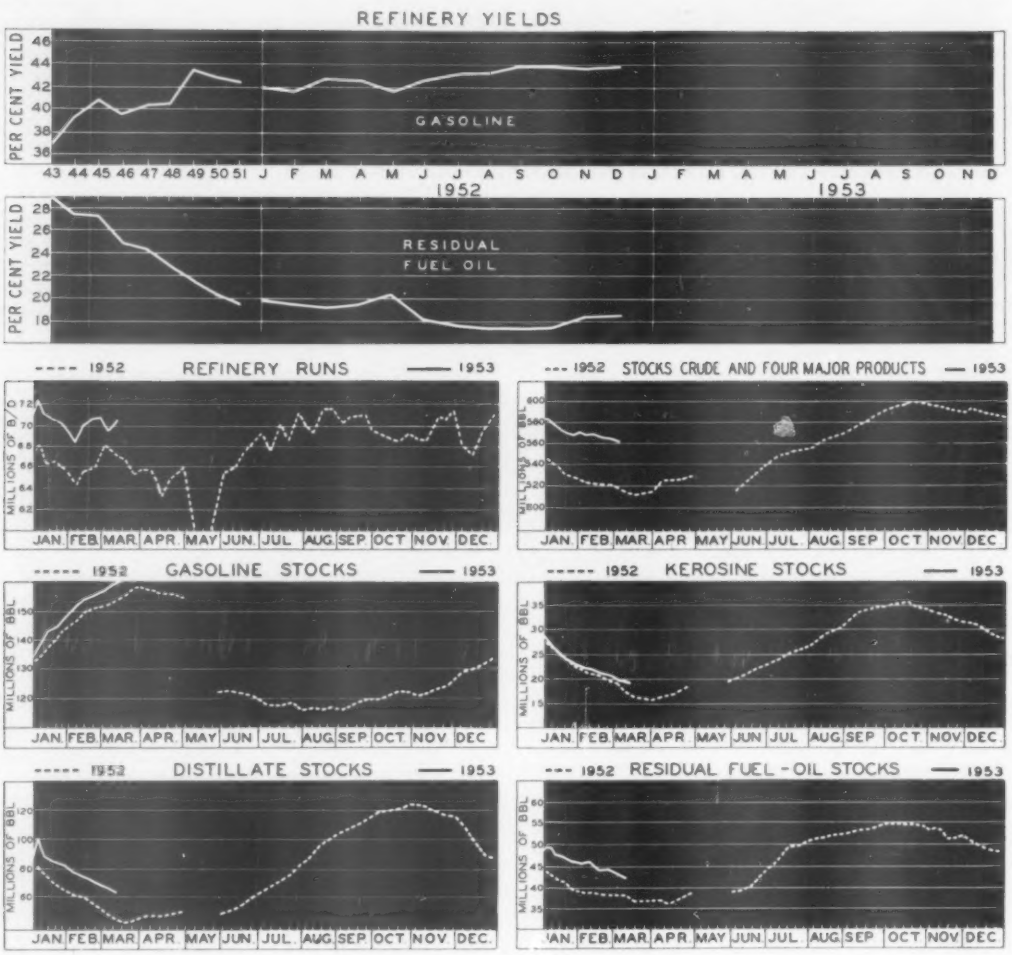




## CRUDE-OIL STOCKS BY STATES OF ORIGIN*

(Thousands of barrels)

| | Mar. 7, '53 | Feb. 28, '53 | Mar. 8, '52 |
|---|---|---|---|
| Pennsylvania Grade | 2,278 | 2,327 | 2,261 |
| Other Appalachian | 1,995 | 2,030 | 2,168 |
| Illinois, Indiana, Michigan | 10,526 | 10,138 | 11,030 |
| Arkansas | 2,824 | 2,997 | 2,804 |
| Louisiana | 16,147 | 16,540 | 13,628 |
| North | 3,097 | 2,986 | 2,833 |
| Gulf | 13,050 | 13,554 | 10,795 |
| Mississippi | 3,748 | 3,797 | 3,489 |
| New Mexico | 7,553 | 7,465 | 7,663 |
| Oklahoma and Kansas | 36,008 | 36,478 | 39,507 |
| Texas | 135,512 | 135,569 | 120,506 |
| East Texas proper | 11,307 | 11,369 | 10,654 |
| West Texas | 65,113 | 64,646 | 54,635 |
| Texas Gulf | 25,805 | 25,828 | 24,939 |
| Other Texas | 33,287 | 33,726 | 30,278 |
| Rocky Mountain | 15,656 | 15,802 | 13,596 |
| California | 32,921 | 32,705 | 30,702 |
| Foreign | 7,280 | 8,275 | 5,472 |
| Total | 272,448 | 274,123 | 252,826 |

*Bureau of Mines.

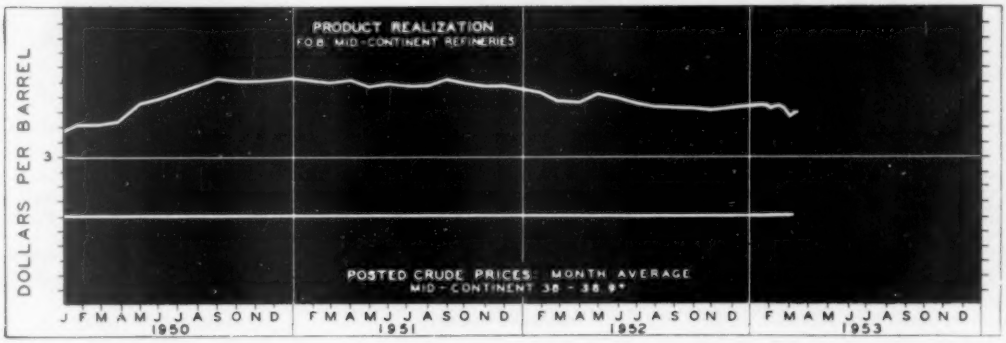

REFINERY YIELDS
PER CENT YIELD
GASOLINE
43 44 45 46 47 48 49 50 51 J F M A M J J A S O N D J F M A M J J A S O N D
1952
1953
PER CENT YIELD
RESIDUAL FUEL OIL
---- 1952 REFINERY RUNS —— 1953
MILLIONS OF B/D
JAN FEB MAR APR MAY JUN JUL AUG SEP OCT NOV DEC
--- 1952 STOCKS CRUDE AND FOUR MAJOR PRODUCTS — 1953
MILLIONS OF BBL
JAN FEB MAR APR MAY JUN JUL AUG SEP OCT NOV DEC
----- 1952 GASOLINE STOCKS —— 1953
MILLIONS OF BBL
JAN FEB MAR APR MAY JUN JUL AUG SEP OCT NOV DEC
----- 1952 KEROSINE STOCKS —— 1953
MILLIONS OF BBL
JAN FEB MAR APR MAY JUN JUL AUG SEP OCT NOV DEC
----- 1952 DISTILLATE STOCKS —— 1953
MILLIONS OF BBL
JAN FEB MAR APR MAY JUN JUL AUG SEP OCT NOV DEC
--- 1952 RESIDUAL FUEL - OIL STOCKS — 1953
MILLIONS OF BBL
JAN FEB MAR APR MAY JUN JUL AUG SEP OCT NOV DEC

## A.P.I. REFINERY REPORT, MARCH 14

(Thousands of barrels)

| District— | Daily avg. runs | Daily average production Gaso.* | Kero. | Dist. | Resid. | Stocks‡ Gaso.† | Kero. | Dist. | Resid. | Bureau of Mines, March 1952 Daily avg. runs | Daily average production Gaso.* | Kero. | Dist. | Resid. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| East Coast | 1,094 | 395.6 | 35.7 | 269.6 | 264.2 | 35,436 | 8,051 | 20,931 | 10,834 | 940 | 385.3 | 44.3 | 226.6 | 229.6 |
| Appalachian: | | | | | | | | | | | | | | |
| District 1 | 106 | 40.9 | 8.3 | 16.3 | 11.6 | 4,164 | 449 | 969 | 464 | 109 | 49.0 | 5.8 | 14.8 | 13.2 |
| District 2 | 92 | 53.0 | 6.6 | 16.0 | 16.4 | 1,805 | 287 | 408 | 172 | 71 | 35.2 | 4.2 | 11.6 | 17.6 |
| Ind., Ill., Ky. | 1,258 | 658.4 | 67.6 | 219.6 | 166.3 | 37,206 | 3,934 | 9,374 | 4,084 | 1,253 | 632.6 | 81.7 | 228.7 | 174.8 |
| Okla., Kans., Mo. | 586 | 340.1 | 12.9 | 133.6 | 56.7 | 18,129 | 1,175 | 6,756 | 1,075 | 535 | 293.9 | 18.2 | 119.6 | 63.8 |
| Inland Texas | 261 | 169.9 | 14.8 | 48.4 | 34.0 | 6,637 | 267 | 1,174 | 904 | 236 | 166.3 | 13.4 | 40.4 | 38.0 |
| Texas Gulf Coast | 1,741 | 781.7 | 133.1 | 434.0 | 276.7 | 21,775 | 2,338 | 7,361 | 6,277 | 1,705 | 727.1 | 145.4 | 391.6 | 265.2 |
| La. Gulf Coast | 513 | 256.6 | 54.4 | 140.0 | 61.4 | 7,870 | 1,135 | 3,621 | 1,559 | 499 | 240.3 | 49.9 | 143.9 | 59.0 |
| N. La. and Ark. | 87 | 35.1 | 8.3 | 19.8 | 9.0 | 3,510 | 404 | 1,187 | 82 | 71 | 31.6 | 6.7 | 19.2 | 4.9 |
| Rocky Mountain: | | | | | | | | | | | | | | |
| New Mexico | 16 | 9.3 | | 2.0 | 3.1 | 139 | | 28 | 28 | 18 | 10.4 | 1.0 | 2.6 | 4.0 |
| Other Rocky Mtn. | 245 | 107.7 | 2.3 | 52.3 | 46.0 | 6,951 | 290 | 1,600 | 856 | 217 | 101.4 | 8.7 | 42.9 | 46.7 |
| California | 1,061 | 458.4 | 2.4 | 154.7 | 385.7 | 17,247 | 310 | 9,136 | 15,949 | 986 | 395.7 | 6.6 | 158.2 | 356.8 |
| Mar. 14, 1953 | 7,060 | 3,306.7 | 346.4 | 1,506.3 | 1,331.1 | 160,869 | 18,640 | 62,545 | 42,284 | 6,640 | 3,068.8 | 385.9 | 1,400.1 | 1,273.6 |
| Mar. 7, 1953 | 6,963 | 3,304.4 | 423.7 | 1,471.0 | 1,290.7 | 159,434 | 19,843 | 65,476 | 43,628 | | | | | |
| Mar. 15, 1952 | 6,693 | 3,108.0 | 353.1 | 1,459.9 | 1,283.0 | 154,740 | 16,442 | 51,665 | 36,417 | | | | | |

*At refineries including natural blended. †Finished and unfinished. ‡At refineries, bulk terminals, in transit, and in pipe lines.


PRODUCT REALIZATION
F.O.B. MID-CONTINENT REFINERIES
DOLLARS PER BARREL
3
POSTED CRUDE PRICES: MONTH AVERAGE
MID-CONTINENT 38 - 38.9°
J F M A M J J A S O N D
1950
F M A M J J A S O N D
1951
F M A M J J A S O N D
1952
F M A M J J A S O N D
1953

**In this trend chart refinery realization is based on average Mid-Continent grade crude oil (not 38° gravity only) and average prices for refinery products as published in The Oil and Gas Journal basis Oklahoma (Group 3). Refinery yields confined to gasoline, kerosine, distillate and fuel oil. Realization averaged $3.29 for week ended March 7, $3.29 for previous week, and $3.37 for March 1952. The above trend information is based on volumes and current prices and therefore does not reflect changes in operating costs.**

## REPRESENTATIVE QUOTATIONS

Representative spot-market quotations of leading suppliers as of March 18, 1953. Figures are f.o.b. plant for tank-car shipments in cents per gallon, except for residual fuel oil which shows the price per barrel and wax, in cents per pound.

### GASOLINE, KEROSINE, AND FUEL OILS

| | Mid-Continent Group 3 | New York Harbor (barge) | Texas Gulf Coast |
|---|---|---|---|
| Regular gasoline, 80-82 octane | 10¼-10½ | 12.125-12.75 | 10¾-11 |
| Premium gasoline, 86-88 octane | 11¼-11½ | 13.25-14.0 | 11¾-12 |
| 42-44 w.w. kerosine | 8⅜-8¾ | 10.40-10.65 | 9 |
| No. 2 straw fuel oil | 7½-7¾ | 9.40-9.65 | 8 |
| No. 6 residual | $0.85-1.00 | $1.90-2.15 | $1.50-1.65 |

### NATURAL GASOLINE

| | Group 3 | North Tex. | N. La. |
|---|---|---|---|
| Grade 26-70 | 5½ | 5 | 5¼ |
| Grade 18-55 | 6.60 | 6.10 | 6.35 |

### LUBRICATING OILS

**South Texas**

| | |
|---|---|
| 200 vis., No. 2-3 neutral | 12-13 |
| 750 vis., No. 3-4 neutral | 15-16 |
| 2,000 No. 5-6 neutral | 17-18 |

### LUBRICATING OILS

**Mid-Continent**

| | |
|---|---|
| 150-160 vis., D bright stock, 0-10 pp. | 21-22 |
| 200 vis., No. 3 neutral, 0-10 pp. | 12-13 |

**Western Pennsylvania**

| | |
|---|---|
| 145-155 vis., 10 p.t. bright stock | 27.5 |
| 180 vis., 0 p.t. neutral | 29.5 |

### WAX

**Mid-Continent**

| | |
|---|---|
| 132-134 A.M.P. | 5.5 |

VERY mild strengthening of the dirty-tanker market was reported for the second week in March. Several tankers were taken for the Caribbean-East Coast haul at Maritime Commission base minus 40 per cent compared with fixtures at USMC minus 45 per cent a week earlier. This moderate increase was not due to any temporary shortage of tankers since plenty of additional tonnage was available at the reported price level.

Continuation of relatively low tanker rates is making it possible to move heavy fuel into the New York Harbor area at costs that are putting some pressure on the normal posted price of $2.00 a barrel for barge delivery. Material is available and is moving at $1.90, and major suppliers are reported to be meeting this competition on a customer-by-customer basis rather than by a general reduction in postings.

Low tanker rates also caused rapid movement out of the Gulf Coast, resulting in an inventory gain on the East Coast of almost 2,000,000 bbl. compared with last year and a reduction of about 500,000 bbl. on the Gulf Coast.

Decontrol of No. 2 distillate fuel on March 12 was not followed by any increases in postings for this product. On the East Coast and on inland markets, No. 2 has been moving at prices below the old ceilings.

Suppliers in the Mid-Continent are reducing kerosine and distillate inventories in pipe-line terminals by a process of trading. Most of these suppliers will be able to cut heating-oil stocks to levels more in line with moderate demands during the spring months. Pipe-line stocks of these fuels will be held to a minimum between now and summer when stocking of kerosine and distillate will be permitted without demurrage in order to build up stocks near points of consumption to meet winter demands. Refinery stocks in the Mid-Continent are expected to increase over the next few weeks.

## CRUDE PRICES
## GRAVITY SCHEDULE

| | Signal Hill, Calif‡ | Okla. homa, Kansas | Gulf Coast Tex.* | West Tex‡ |
|---|---|---|---|---|
| 14-14.9 | $1.87 | | | |
| 15-15.9 | 1.93 | | | |
| 16-16.9 | 1.99 | | | |
| 17-17.9 | 2.05 | | | |
| 18-18.9 | 2.11 | | | |
| 19-19.9 | 2.18 | | | |
| 20-20.9 | 2.24 | $2.25 | | $2.12 |
| 21-21.9 | 2.30 | 2.27 | | 2.14 |
| 22-22.9 | 2.37 | 2.29 | | 2.16 |
| 23-23.9 | 2.45 | 2.31 | | 2.18 |
| 24-24.9 | 2.53 | 2.33 | $2.56 | 2.20 |
| 25-25.9 | 2.61 | 2.35 | 2.58 | 2.22 |
| 26-26.9 | 2.69 | 2.37 | 2.60 | 2.24 |
| 27-27.9 | 2.76 | 2.39 | 2.62 | 2.26 |
| 28-28.9 | 2.83 | 2.41 | 2.64 | 2.28 |
| 29-29.9 | 2.91 | 2.43 | 2.66 | 2.30 |
| 30-30.9 | 2.97 | 2.45 | 2.68 | 2.32 |
| 31-31.9 | 3.04 | 2.47 | 2.70 | 2.34 |
| 32-32.9 | 3.12 | 2.49 | 2.72 | 2.36 |
| 33-33.9 | | 2.51 | 2.74 | 2.38 |
| 34-34.9 | | 2.53 | 2.76 | 2.40 |
| 35-35.9 | | 2.55 | 2.78 | 2.42 |
| 36-36.9 | | 2.57 | 2.80 | 2.44 |
| 37-37.9 | | 2.59 | 2.82 | 2.46 |
| 38-38.9 | | 2.61 | 2.84 | 2.48 |
| 39-39.9 | | 2.63 | 2.86 | 2.50 |
| 40 and above | | 2.65 | 2.88 | 2.52 |

*For crude from Daboval, El Campo, and Sand Point.

‡Includes Lea County, New Mexico.

Last general price change represented a 5¢ cent increase, effective December 6, 1947.

‡Standard Oil Co. of California.

## FLAT CRUDE PRICES

| | |
|---|---|
| Representative posted schedules per barrel | |
| Louisiana: | |
| Beauregard Parish | 2.60 |
| Cotton Valley (distillate) | 2.85 |
| Cotton Valley (crude) | 2.70 |
| Texas: | |
| East Texas | 2.65 |
| Pecos County (Yates) | 2.35 |
| Conroe | 2.83 |
| Van | 2.48 |
| Pennsylvania Grade: | |
| Bradford | 4.40 |
| Southwest Pennsylvania | 3.97 |
| West Virginia | 39.1 |
| Illinois Basin | 2.77 |

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1 OILWELL Steam Pump, 16¼ x 7⅜ x 20". This pump is in excellent condition, may be seen at Makin Drilling Company Yard, Hobbs, New Mexico. Makin Drilling Company, Box 1628, Hobbs, New Mexico.

FOR SALE: Jennings, Louisiana, many used steel storage tanks, 100 to 37,000 bbl. Hardware, connections and pumps. Southern Oil Agency, P.O. Box 880, Jennings, Louisiana.

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Gaso Duplex 4½" x 6" Power Pumps with Chrysler C-36 Engines, skid mounted, immediate delivery. Also Byron Jackson, Carter Centrifugal Units. Westinghouse 20-25-50 KW Generating Units.

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WELL drilling equipment, new or used Spudders, rotaries, core & shot hole drills, tools, pipe, bits, blocks, pump jacks, valves. Everything for well drilling and service. Fishing tools rented. Pressey & Son, Pueblo, Colo.

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CATERPILLAR D4 Tractor with Trackson Pipelayer in excellent condition. Will rent with purchase option. Write—J. W. Kerby, Chanute, Kans.

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Approximately 100 miles 6⅝" O.D. 18.97# Used Lapweld Line Pipe in single random lengths, plain ends beveled.
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87' Lee C. Moore Cantilever Derrick located East Central Oklahoma. Drilled one well since complete overhaul by Lee C. Moore. 4½' substructure, steel floor, 4' drop wings. $8,000.00. Box G-329, The Oil and Gas Journal, Tulsa, Oklahoma.

FOR SALE: 1 43 Star spudder complete with tools. Price $6500.00. Four miles east of Delaware, Oklahoma. Call Tulsa 3-0390. After five 54-1488. C. L. Sutton.

1—1000 H.P., 600 KW, 300 RPM, COOPER BESSEMER, Type LTG natural gas engine. 1—500 H.P., 350 KW, 225 RPM, FULTON, Class BGG, natural gas engine. 2—300 H. P., 200 KW, 200 RPM, FULTON, Class 3 BG Diesel Engines. (All 3 phase, 60 cycle, 2300 volts). Units can be seen in operation. 12—300 H.P., 900 RPM, STERLING - VIKING natural gas engines only. Completely rebuilt and guaranteed. MAX E. LANDRY, INC., P.O. Box 2238, Tulsa, Oklahoma. Ph. 72-1519.

FOR SALE: Model P oil well mud pump 6 X 12. A1 condition, can be inspected, ideal for light rotary or reverse circulator. $4500.00. Davon Drilling Company, Oklahoma City, Okla.

FOR SALE: 2—New B. J. Multiplex 6 x 8 x 10 pipe line pumps. 1000 Gal. @ 400 ft., maximum head 2000'. List $3468.00 each. Our Price $1250.00 each. Bender Oil Operations, P.O. Box 52, Bakersfield, California.

FOR SALE: Gardner Denver 4½ x 5 FXF Mud Pump—Good condition. Whitlock, 2062-R, Pampa, Texas.

CARDWELL R. L. 3 Drum Spudder, equipped with lots of extras, including rotary drive clutch, G.K.U. Waukesha Motor. All in A-1 condition. Just shut down on 7800' well. Can be seen on our yard in Midland, Texas. Call C. A. Hurst Drilling Co., Midland, Texas, phone 3-3532 or Mr. Vaught 2-2088.

**FOR SALE**
29,000 feet new 2⅜", 4.43#, E.W., R-2 Upset 8rd Thread Tubing W.J-55 Couplings, at 72c per foot. 9,126 feet new 4½", 9.4#, E.W., R-2 8rd Thread Casing W.J-55 Couplings, at $1.39 per foot. All FOB McPherson, Kansas.
**E. K. CAREY DRILLING CO., INC.**
**Phone 241 P.O. Box 620**
**McPherson, Kansas**

## FOR SALE

Complete National 100 Rig including 3 PTD-6 Superior Diesel Engines with dual fuel equipment. 136' Lee C. Moore Mast with 8' substructure, 2 C-350 Ideal Power Pumps, Ideal Type 548 TC Traveling Block, Type R3 Swivel, and Type MS-20½ Rotary Table. Excellent condition, priced reasonable, located in Montana. Complete inventory upon request.

**Box G-341**
**The Oil and Gas Journal,**
**Tulsa, Oklahoma**

# FOREIGN A.P.I. PIPE

**Immediate Delivery from Houston Stock**

## POPULAR SIZES, WEIGHTS and GRADES

**No P.A.D. Tickets Required**

***Phone, Write or Wire for Prices***

## LUCEY PRODUCTS CORPORATION

**TULSA, OKLAHOMA**

**624 So. Cheyenne** **Phone LD - 204**

## EQUIPMENT FOR SALE

IMMEDIATE delivery large tonnage API Casing, Line Pipe. Large tonnage #1 used $10^{3}/_{4}$ OD .203 wall EW Pipe, also other specifications used and reconditioned pipe and tubing. Weil-Robbins, Inc., 117 Liberty Street, New York, N. Y.

FOR SALE: Cardwell, model RL, Beam type cable tool drilling unit. At present in operation in West Central Kansas. Complete inventory and price furnished on request. K & A Drilling Co., Phone 448R or Box 497, Ellinwood, Kansas.

**FOR SALE**

**SURPLUS**

**SHOP EQUIPMENT**

1—Lodge & Shipley Hollow Spindle Lathe, 8-$^{7}/_{8}$" hole, 25" Swing, 16' Bed, Hardened & Ground V-Ways. Purchased new in 1950.
1—Seneca Falls Engine Lathe, 12" Swing x 6' Bed. Motor driven through Turner Unit.
1—Bridgeport 8" Hole Hollow Spindle Lathe, **32" Swing**, 16' Bed. Motor driven through Turner drive.
1—15" R. A. Kelly Company Hydraulic Shaper. Motor Driven.
1—21" Champion Post Type Drill Press. Motor Driven.
1—400 AMP Lincoln Electric Welder. 220 Volt, 60 Cycle, 3p Motor Driven.
1—Kalamazoo P45 Band Saw. Motor Driven.
1—Buffalo 14" Post Type Drill Press. Motor Driven.
1—200-Ton Hydraulic Horz. Press. 10' inside clearance. Motor driven pump.

This is a part of a complete Machine Shop. Location is 2601 Butternut, Abilene, Texas. Inspection may be made at any time. Shop could be readily dismantled and moved or operated at its present location.

**PRICED TO SELL**

**Phone—Wire—Write**

**Empire Machinery Co.**

**Box 4028 1613 Tower Petroleum Bldg.**
**Odessa, Texas Dallas, Texas**

## EQUIPMENT FOR SALE

TWO FAILING 1500 heavy duty drills with 4½ x 6 pumps, automatic pulldown, and mounted on International trucks. Write P. O. Box 819, Longmont, Colorado. Phone 1333.

FOR SALE: Moore cantilever derrick; Wilson Giant two motor draw works; two pumps, rotary; block and hook. Write Box 3246, Corpus Christi, Tex.

1—CARDWELL Q rod & tubing unit with 7 x 8 telescoping mast. Mounted on 1950 2-ton Chevrolet truck. Some tools. Write or call Kent Well Servicing Company, Phone 1068, El Dorado, Kansas.

FOR SALE—Caterpillar D4 with Hydraulic angle blade. Good condition, wide gauge. Atlee Schlabach, Charm, Ohio.

FOR SALE: Franks "2000" Rotary Drill, on tandem lowboy trailer—exceptionally good shape. Contact R. F. Hare, 2018 W. T. Waggoner Bldg., Fort Worth. Ph. FA-4646.

**SALES and rentals of cable drilling and fishing tools, casing and equipment, from the Southwest's largest stock of used cable tools and oil field supplies. Degen Pipe and Supply Co., Tulsa, Oklahoma.**

MOUNTED Rotary Drilling Rig. Dodge Truck, 1500 feet, Two Men Operate. Fast, Durable, Efficient, Roller Bearing. Money Maker. $5000. Box 106, Seminole, Oklahoma.

USED ROTARY, cable tools, and production equipment. E. A. Kelly, 3131 S.E. 29th Street, P. O. Box 861, Oklahoma City. Phone Jackson 56407.

FOR SALE: One double drum Super-Mogul Wilson Spudder, powered by PA-100 International motor. $1500.00. Fox Well Servicing Company, Healdton, Oklahoma.

***Longer Tool Life!***

**ARMITE DRILL COLLAR**

**& TOOL JOINT COMPOUND**

**ARMITE LABS., 6509 Broad St., Los Angeles 1, Calif.**
The Wm. H. Mason Co., 212 N. Denver Ave., Tulsa, Okla.

## EQUIPMENT FOR SALE

GAS METERS FOR SALE. Westcott, Foxboro and Emco. Good condition. Geo. R Milner, Box 124, Okmulgee, Oklahoma.

TWO used 5,000-barrel steel tanks located Sunburst, Montana, one in good condition, one fair. Hardrock Oil Co., Box 1242, Great Falls, Montana.

TRAILER POLES, steel, 30' long; 4½" OD $32.50; 5½" OD $37.50. General Wrecking Company, 3544 La Salle St., St. Louis, Missouri.

EQUIPMENT FOR SALE: 500 KW operating 480 volt power plant complete with 2 Worthington 300 HP type CG-8 vertical 4 cycle gas engines, 1 Worthington 150 HP type BG-5 gas engine, 2 General Electric 200 KW generators, 1 General Electric 100 KW generator, 1 General Electric 5 KW exciter, and General Electric switchboard. American Liberty Oil Company, Box 1011, Mt. Pleasant, Texas.

FOR SALE: Bucyrus Erie 36L drilling machine with top to bottom tools. Excellent condition. Located at Odessa. Phone 6-5974, Box 2204, Odessa, Texas.

FOR SALE: Wilson Giant Spudder with double mast pole. All tailing-in tools for 5½ and 7 inch. Also rotary equipment used as combination rig. All equipment in A-1 working condition and priced to sell for cash. Call Ray Willis, Phone 924, Mt. Carmel, Ill.

FOR SALE: WILSON GIANT SPUDDER with double mast pole. All tailing-in tools for 5½ and 7 inch. Also rotary equipment used as combination rig. All equipment in A-1 working condition and priced to sell for cash. Call Ray Willis, Phone 924, Mt. Carmel, Ill.

**FOR SALE: One Barrel Type Ethyl Lead Plant, Hutex Oil & Refining Company, P. O. Box 2146, Houston, Texas.**

FOR SALE: 8—Shriver 42"x42" cast iron Filter Presses, Plate & Frame type, 18, 27, and 54 chambers, 1" cake; 15—Sperry 18"x18" cast iron Filter Presses, 11 chambers; 2—212 Sweetland Filters for 36 leaves on 4" centers. Immediate shipment. Attractively priced. Consolidated Products Co., Inc., 17-20 Park Row, New York 38, N. Y. BArclay 7-0600.

STORAGE TANKS—FOR SALE: Three—55,000 bbl. steel tanks with steel roofs. Jimmy Heath, Henrietta, Texas.

**FOR SALE: R. L. Dubbledrum Cardwell fully equipped. Oklahoma City, Oklahoma. Melrose 8-5108.**

**WANT EQUIPMENT: Did you find the equipment you wish to purchase in this column? If not, use an "Equipment Wanted" classified advertisement to find it. It is available somewhere and Journal classified advertisements will find it. See box heading for classified rates, or write The Oil and Gas Journal.**

## EQUIPMENT WANTED

WANTED: Three engine compound for Wilson Titan drawworks. Makin Drilling Company, Box 1628, Phone 3-3141, Hobbs, New Mexico.

WANTED: One Thrible Jack-knife and substructure. No Junk Wanted. Makin Drilling Company, Phone 3-3141, Hobbs, New Mexico.

WILL PAY highest prices for used casing, used line pipe, abandoned leases, or other surplus lease equipment. Your idle producing equipment is worth dollars. Green Pipe & Supply Co., Box 1383, Tulsa, Oklahoma.

WANTED to buy, small vacuum tower and other vacuum equipment. Box G-382, The Oil and Gas Journal, Tulsa, Oklahoma.

WANTED: Six asphalt storage tanks, 1000 to 1500 barrel capacity. Trinidad Highway Company, Inc., Zionsville, Indiana.

EQUIPMENT NOT IN USE: Did you find a buyer in this column for the equipment you have for sale? Someone wants it and an "Equipment For Sale" classified advertisement in the Journal will find a buyer. See box heading for classified rates or write The Oil and Gas Journal.

***A Client of Ours***

***Offers Installation and Operation of***

**GASOLINE ABSORPTION PLANT**

**GAS GATHERING LINES**

**COMPRESSOR STATIONS**

on interesting terms. For further information please contact: Dept.: O-1.

**MANAGEMENT COUNSELORS INC.**

**37 Wall Street New York 5, New York**

## HELP WANTED

WANTED: High salaried oil office executive, with experience in handling organization partly abroad. Office in New York. Man 40 to 50 preferred. All correspondence will be absolutely confidential. Box G-353, The Oil and Gas Journal, Tulsa, Oklahoma.

OLD established engineering and contracting firm desires engineer for oil and gas process work. Should have two or three years' experience with operating company. Write stating experience and present position to Box G-363, The Oil and Gas Journal, Tulsa, Oklahoma.

CHEMICAL ENGINEER—Responsible engineering position with well-established consulting engineering firm rendering diversified services to industry. Good educational background essential. Experience in petroleum, petrochemicals, fertilizers, market research, economics, process design desirable. Opening immediate. Salary commensurate with ability. Box G-393, The Oil and Gas Journal, Tulsa, Oklahoma.

MASTER Mechanic, qualified to install and maintain large diesel engines as well as pumps and accessory equipment on pipe line. Must be capable of organizing and directing maintenance program. Location, North Central Area. Please include experience and salary expected in reply. Box G-380, The Oil and Gas Journal, Tulsa, Oklahoma.

MANY Rocky Mountain Petroleum Industry openings for geologists, engineers, draftsmen, and refinery supts. Write Professional Placement Service, 516 University Bldg., Denver, Colo.

MAN experienced in construction and operation of small Natural Gas Distribution Systems. Registered Engineer Preferred. Permanent location in Southeast. Box G-365, The Oil and Gas Journal, Tulsa, Oklahoma.

**SUBSURFACE GEOLOGIST-MICRO-PALEONTOLOGIST**

To work on deep wells in Saudi Arabia, making lithologic and faunal logs from cores and cuttings, interpreting electric logs, and working on field and regional stratigraphic studies. Salary dependent upon experience and qualifications.

Write giving personal history and work experience. Please include telephone number.

**RECRUITING SUPERVISOR, BOX OGJ**

**ARABIAN-AMERICAN OIL CO.**

**505 Park Ave., New York 22, N. Y.**

**WANTED**

**●**

**electrical engineer**

To supervise the operations and maintenance of Microwave Communications and Cathodic Protection Systems for large pipe line company. Location — Detroit, Michigan. Salary open. Include resume of experience and education together with snapshot. All applications treated as confidential.

**Box G-386**

**THE OIL AND GAS JOURNAL**

**Tulsa, Oklahoma**

## HELP WANTED

WANTED—Seismograph Party Chief. Must be fully qualified. Age 27-38. A good opportunity for the right man. Box G-348, The Oil and Gas Journal, Tulsa, Oklahoma.

SEISMIC Party Chief for work in United States with degree in Geophysics, Geology, or Engineering, age 28 to 35, capable of advancing, in small progressive Contract Seismograph Company. Must be good interpreter. Salary commensurate with ability. Please include education and complete brief of experience in first reply. Replies confidential. Box G-351, The Oil and Gas Journal, Tulsa, Oklahoma.

SEISMIC PERSONNEL needed for United States and Canada by well known and expanding contract geophysical company. Address Box E-863, The Oil and Gas Journal, Tulsa, Oklahoma.

PIPE LINE WELDER, at least 4 years' experience in welding on loaded crude lines. Must be able to supervise and direct small maintenance gang in addition to regular duties as welder. Location, North Central Area. Age—25-45. Box G-358, The Oil and Gas Journal, Tulsa, Oklahoma.

INDEPENDENT GAS PRODUCER NEEDS EXPERIENCED PRODUCTION SUPERINTENDENT FAMILIAR WITH DRILLING, COMPLETIONS AND PRODUCING OPERATIONS IN EAST TEXAS AND NORTH LOUISIANA. REPLIES CONFIDENTIAL. Box G-388, The Oil and Gas Journal, Tulsa, Oklahoma.

GRADUATE Chemical Engineers and Chemists with or without experience for positions in Research and Development department, located in Tulsa. State qualifications and salary expected. Write Personnel Department, P. O. Box 381, Tulsa 2, Oklahoma.

RESEARCH GEOPHYSICIST to head group doing theoretical and interpretative research in exploration geophysics for major oil company. Location in Mid-Continent Region. Ample opportunity for well-qualified man with advanced training and experience. Please give complete history of education and experience in first letter. Reply will be kept confidential. Address Box G-364, The Oil and Gas Journal, Tulsa, Oklahoma.

OIL Industry Employment Service, 405 Tuloma Bldg., Tulsa, Okla. 4-5974. Tom Robinson, owner. For Technical and Trained Personnel, including LPG.

CHEMICAL engineer graduate, 3 or more years experience. Wanted for process calculation work in the natural gas-gasoline field. Give resume of personal status, working experience, present salary. State salary desired. Box G-385, The Oil and Gas Journal, Tulsa, Oklahoma.

THE POSITION YOU WANT: Oil industry companies are looking for men to fill every conceivable kind of position. If you didn't find the position in this column that you are looking for, use a "Situation Wanted" classified advertisement to state your qualifications. Some company is probably looking for your ability. See box heading for classified rates or write The Oil and Gas Journal.

**WATER FLOOD**

Graduate in engineering or physical sciences to conduct water flood research studies in field. Previous secondary recovery experience desired but academic background, interest in oil production and ability to learn are basic requirements. Initial location, Nowata, Oklahoma. Salary open. Excellent opportunity to join expanding research staff of major company. Send personal and employment history to:

**SINCLAIR RESEARCH LABORATORIES, INC.**

**Box 3006, Whittier Station, Tulsa, Okla.**

## HELP WANTED

FOREIGN EMPLOYMENT. List of oil companies and drilling contractors showing where to apply for foreign jobs. OIML Co., Box 2603, Tulsa, Okla. $5.00 cash.

## SITUATIONS WANTED

GRADUATE teacher: completed two contracts in Venezuela, one two year contract in Arabia. Chicago experience in all grades. Available September for other foreign assignments. Box G-359, The Oil and Gas Journal, Tulsa, Oklahoma.

ENGINEER, employed, 11 years experience Major company and Service company, drilling and production, field and staff work. Box G-345, The Oil and Gas Journal, Tulsa, Oklahoma.

GRADUATE PETROLEUM ENGINEER Married, age 32, 7 years experience production and drilling, Gulf Coast area. Desires permanent position w/growing organization. Box G-337, The Oil and Gas Journal, Tulsa, Oklahoma.

MANAGER or assistant manager, 42, truck transportation or wholesale gasoline agency, 13 years' experience independent refinery. Box 322, Big Spring, Texas.

AVAILABLE: Twelve chemical engineers with 3-8 years varied experience in refining, now working for sub-par salaries. Write requirements to Box G-366, The Oil and Gas Journal, Tulsa, Oklahoma.

ATTENTION: Well established oil well drilling contractor desires to manage and supervise: Individuals', groups', small or medium-sized oil companies' drilling, production and operating problems in Central and Western Texas, and New Mexico. Personal interview by appointment is desired. Makin Drilling Company, Box No. 1628, Ph. No. 3-3141, Hobbs, New Mexico.

GRADUATED Petroleum and Civil Engineer, European, 42, active, 5 idioms, actually occupied as Petroleum Equipment and Cost Engineer, wants interesting and useful Manufacturing Presentation for Colombia, to establish himself as representative in Barranquilla. Box G-394, The Oil and Gas Journal, Tulsa, Oklahoma.

EXECUTIVE Secretary: Extensive oil and legal experience. Prefer small office. Box G-395, The Oil and Gas Journal, Tulsa, Okla.

EXPERIENCED PETROLEUM geologist, seven years western Oklahoma, west Texas, three years California. Surface, subsurface, well sitting, photo. Location open. Box G-391, The Oil and Gas Journal, Tulsa, Oklahoma.

SALES REPRESENTATIVE position wanted in Oil Industry. 8 years varied Major Company experience, married, age 30. Box G-392, The Oil and Gas Journal, Tulsa, Oklahoma.

PETROLEUM Engineer, 3½ years experience. Presently employed as Drilling Engineer, Age 32. Available late spring. Resume on request. Box G-333, The Oil and Gas Journal, Tulsa, Oklahoma.

PETROLEUM GEOLOGIST, TWO YEARS EXPERIENCE ON REPRESSURING PROJECT DESIRES POSITION WITH INDEPENDENT OPERATOR. Box G-387, The Oil and Gas Journal, Tulsa, Oklahoma.

CHEMICAL Engineer, 32, six years asphalt research experience with major company. Desires refinery production position in south or southwest. Box G-389, The Oil and Gas Journal, Tulsa, Oklahoma.

**ALEC CROWELL**

an experienced oil man seeks a connection (job) due to fact that last three deep tests were failures and entire income and assets being liquidated pay creditors and avoid bankruptcy. Twenty-eight years with Empire, Del Rey, Shamrock; Arkansas, Texas, Mississippi Commissions; war service Dept. Interior, FPC, REA, OPS; gas purchaser for Texas Eastern, Texas Illinois, owned interest 13 producers three states. Well educated, healthy, wide acquaintance, age forty-eight. Please write liquidators for detail.

**DODD, HIRSCH & BARKER**

**Attorney, Carondelet Bldg., Phone CAnal 7265, New Orleans, La.**

## SITUATIONS WANTED

GEOLOGIST—Ph.D. with many years experience in all phases of petroleum exploration and with an outstanding record of successful oil and gas finding. Will be available April 1st for full time work or on a part-time retaining basis. If you need ideas for drilling prospects, this is an excellent opportunity and should be investigated. Box G-373, The Oil and Gas Journal, Tulsa, Oklahoma.

COMPLETION and production man experienced in Acidizing, Fracturing and workover desires change. Now employed in West Central Texas. Box G-370, The Oil and Gas Journal, Tulsa, Oklahoma.

ADMINISTRATOR, Executive. 14 years with major supply company, presently employed by same. Store and office manager, sales, perpetual inventory, tubular, payroll, personnel. 42 years old, excellent references. Will relocate. Box G-379, The Oil and Gas Journal, Tulsa, Oklahoma.

SALES Engineer—Ch.E., Age 28, Married, 3½ years refinery experience, 2 years sales experience with major oil company. Box G-382, The Oil and Gas Journal, Tulsa, Oklahoma.

GRADUATE CIVIL ENGINEER, 28, married, 5 years crude oil trunk line experience. Desire more experience in design or construction with minimum travel. Need confidential consideration. Box G-378, The Oil and Gas Journal, Tulsa, Oklahoma.

EXPERIENCED oil operator wants to represent parties planning active drilling program in Texas, retainer and interest basis. Bank references. Box G-383, The Oil and Gas Journal, Tulsa, Oklahoma.

THE RIGHT MAN: Can you fill the position you have open from the qualifications listed in this column? Men are always looking for an opportunity to improve themselves. Use a "Help Wanted" Journal classified advertisement to find the men you need. See box heading for classified rates or write The Oil and Gas Journal.

## WANTED

WANTED to purchase Petroleum statistical guide (Vance Rowe) monthly reports for Western Kansas—years 1941 through 1952 in good readable condition. Box G-360, The Oil and Gas Journal, Tulsa, Oklahoma.

## PRODUCTION WANTED

**WE WANT TO BUY PRODUCTION**

We are reliable and financially responsible . . . Bank References furnished . . . **We are not Brokers.** We prefer direct negotiations with principals . . . but we will negotiate with brokers and protect them. We are only interested in important production . . . the bigger the deal the better. All inquiries will be held in strict confidence and will be given prompt attention. In submitting the proposals . . . give us all of the pertinent data possible. We are prompt cash buyers with substantial seven figure capital.

**Box G-390**
**THE OIL AND GAS JOURNAL**
**Tulsa, Oklahoma**

## BUSINESS OPPORTUNITIES

If you need money for financing oil and mining propositions, order up-to-date mailing list. 1000 names and address of investors. $15.00. W. K. Kyle, 1006 Dallas Avenue, Houston, Texas.

WANT half interest small still for straight gas and tractor fuel. Excellent location new field. Jonnum Mfg. Co., Pittsburg, Kansas.

**SOUTHEAST NEW MEXICO INDICATED OILFIELDS**

Engineering reports based on factual evidence developed by drilling & seismograph surveys. Indicate several important new oilfields in PERMIAN & PENNSYLVANIA ZONES. Oil Men & Investors who appreciate unbiased facts. Furnished details on these important areas gratis.

**W. J. PETERMAN, Geologist**
**Portales, New Mexico**

## LEASE AND DRILLING BLOCKS

GET in on the shallow Oil Play on the West side of the Illinois Basin for drilling blocks call or write W. S. Miller, Assumption, Ill., or Alfred M. Branyan, Moweaqua, Ill. Phones Assumption 90 or Moweaqua 2446.

DALLAM COUNTY, TEXAS: 8000 acres solid block one owner. ½ County leased to Major Companies. $1.25 bonus, $1.00 rentals, 10 year commercial lease. Combest Royalty Company, Amarillo, Texas.

WILL pay cash instantly for leases (large blocks), royalties, mineral deeds, production. Write fully—P. O. Box 2153, Denver Colorado.

**LEASES ROYALTIES**
**Producing and Nonproducing**
**Bought and Sold—Any Area**
**Inquiries Invited**
**B. D. BUCKLEY**
**6635 Delmar Ave., St. Louis 5, Mo.**

**DRILLING PROPOSITIONS WANTED**

Am ready to cut a few more holes. Will drill proven; semi-proven or wildcat. Submit complete information, including geology, if available. All propositions held strictly confidential. **Box G-376, The Oil and Gas Journal, Tulsa, Oklahoma.**

## Oklahoma Oil Production . . .

6 flowing wells producing 240 bbls. daily. 4 offset locations, one now drilling. High gravity oil, 2675 ft. depth.
65% working interest available for purchase on small cash payment and convenient terms.
Ideal for new company and immediate dividends.
Complete information to qualified principals on request.

**ARTHUR DAVIDOR**
**1412 NW 39th St. Oklahoma City**

## BIGGEST OF ALL OIL BOOMS COMING UP

I offer subject to my final confirmation:

| | | Acre |
|---|---|---|
| 2,000 acres | Moffat County, Colo. | $ 2.00 |
| 480 acres | Washington County, Colo. | 6.00 |
| 40 acres | Jackson County, Colo. | 7.50 |
| 40 acres | Conejos County, Colo. | 5.00 |
| 3,000 acres | Brewster County, Tex. | 4.00 |
| 2,900 acres | Custer County, Mont. | 3.00 |
| 3,500 acres | Weston County, Wyo. | 1.50 |
| 1,280 acres | Bonneville County, Idaho | 1.25 |
| 3,000 acres | Barnes County, N. D. | 1.50 |
| 3,800 acres | Mora County, N. M. | 1.50 |
| 3,000 acres | Rio Arriba County, N. M. | 7.50 |
| 160 acres | Cheyenne County, Neb. | 30.00 |
| 35,000 acres | Hayes County, Neb. | 1.50 |
| 80 acres | Minerals (100%) Rosebud County, Mont. | 15.00 |
| 640 acres | Loving County, Tex. 100% minerals | 45.00 |
| 50 bbl. | per day production Marion County, Kans., per bbl. | $1750.00 |
| 5,000 acres | Imperial County, Calif., 100% mineral deed perpetual | $3.00 |

I will carry certain amount for you on time payments if desired. Ask for DYER'S OIL LEASE TRADER, listing more than 78 other offerings—it's FREE.

**F. W. DYER**
**1835 Champa St., Denver, Colo.**
**Phone Cherry 3576**

## LEASE AND DRILLING BLOCKS

8000 ACRES-2800 acres GRAY COUNTY, TEXAS, Semi-proven oil and gas 3000'. Small cash bonus and little override. 5 year commercial lease $1.00 rentals. Combest Royalty Co., Amarillo, Texas.

DRILLING Deals. See A. L. Bowles, Rollow Bldg., Ada, Okla.

FOR LEASE—One hundred acres Liberty County, Texas, near production. J. G. Minkert, Box 612, Bryan, Texas.

## ROYALTIES

PRODUCING ROYALTY and overrides for sale. Wire-write-call for particulars. JACK EAGLE, 705 City Natl. Bldg., Okla City, Okla. REgent 6-7027.

QUICK CASH: Producing royalties, Overrides or Production . . . no delay. Phone 72-4533, Robert L. Kinkaid . . . P.O. Box 26, Tulsa, Oklahoma.

OFFERING ROYALTIES IN ELK CITY pool and its original trends. Opportunities for big profits in short time likely. A. S. Berry, P.O. Box 1383, Tulsa, Okla.

GET TOGETHER: Both Capital and Royalties are available. If the investment proposition you want isn't listed in this column, use a Journal classified advertisement to find it. See box heading for classified rates, or write The Oil and Gas Journal.

**ROYALTIES WANTED**
**Producing Royalties**
**High Grade Only**
**Send Full Particulars**
**Address**
**C. C. HARMON**
**719 World Bldg., Tulsa, Okla.**
**P.O. Box 2151**

## REAL ESTATE

COMMERCIAL Sites (100 x 235 ft.). Residential lots (75 x 140 ft.) on Highway 83 just north of Minot (restricted to new construction). L. A. Joyce, Box 575, Dial 37-127, Minot, North Dakota.

MODERN NEW OFFICE SPACE available in Tulsa on long term lease only. Located at 15th at Newport, one 4,000 sq. ft. wing comprises 14 offices or 6 suits plus reception room; 2,000 sq. ft. wing comprises 8 offices or 4 suits plus reception room. Air conditioning, parking lot, janitor service, and utilities furnished. Write Irving Shapiro, 1129 E. 15th, Tulsa, Okla.

SPACE IS NEEDED: A Journal display classified advertisement is the quickest way to rent or sell your real estate. In the present period of expansion oil industry firms urgently need the space you have available. If it isn't listed here, you may also find it by stating your needs in these pages. For classified rates see box heading or write The Oil and Gas Journal.

## OIL PRODUCTION

FOR SALE: About 250 bbls. settled production with possibilities for a great increase. Box G-375, The Oil and Gas Journal, Tulsa, Oklahoma.

## FARMS

## CATTLE RANCH

Near Vancouver, B. C. 1,000,000 Ac. 28,944 Ac. Deeded. 5000 Ac. Farm Land. Runs 5000 head. With more development would run 10,000 head. Highly Improved. Price $1,350,000, includes 3250 fine cattle, & all equipment, etc. Terms, or, will take good income property in exchange.

**THIS IS A FINE TAX DEAL**
For this & other Good Ranches.

**LOYAL C. STAHL, JR.**
**630 Title & Tr. Bldg., Phoenix, Ariz.**

## Wilson Supply Occupies New Houston Quarters

Plans of long standing recently culminated in the moving of Wilson Supply Co. into new quarters in Houston. The new location covers more than 50,000 sq. ft. of floor space which accommodates the company's general offices, store, and warehouse. The fishing-tool department will be housed in a separate one-story brick building adjacent to the main office and warehouse building. Wilson Supply Co. was formed by Wallace D. Wilson some 33 years ago, and through its 16 stores located in Texas and Louisiana, and serving the Gulf Coast, East Texas and North Louisiana areas, the company distributes a complete line of drilling equipment, packaged compressor units, and oil and gas-well supplies. Sales offices are maintained in Tulsa, Dallas, Shreveport, and New Orleans.

## MacNamara Joins Beckman As Field Sales Manager

John D. MacNamara, veteran of over 12 years' industrial and instrument sales experience in the eastern states, has been named field sales manager for Beckman Instruments, Inc., South Pasadena, Calif. Formerly textile industry sales manager for Minneapolis-Honeywell Regulator Co., MacNamara will supervise the efforts of Beckman's expanded national field force to provide more complete factory assistance for the research and process industries.

## CF&I Names Hanes to Executive Sales Post

Appointment of R. L. Hanes as assistant to the vice president in charge of sales has been announced by F. S. Jones, vice president of Colorado Fuel & Iron Corp.

Hanes joined C.F.&I. in July 1929. After working in several departments at the Pueblo plant and at the mines, he was transferred to the sales department in 1936. He represented the sales department at Wichita, Phoenix, and Houston. In 1945 Hanes was assigned to the general sales office in Denver, and later as district manager in Fort Worth. In April 1949 he was appointed manager of wire-product sales with offices in Denver.

## Rogers Geophysical Completes Houston Laboratory

Rogers Geophysical Co. has recently completed a new $75,000 laboratory building at its Houston home office. Of modern design to conform to the style of the office, the new lab is completely equipped for geophysical work. Facilities include a shielded and soundproof room for testing of geophysical instruments, machine shop for building of the instruments, and equipment for research and development of new instruments.

# ADVERTISERS IN THIS ISSUE


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## LEGAL

Sealed bids on Oil and Gas leases on 19,973.80 acres of Tribal and Allotted Indian lands on the Fort Peck Indian Reservation, Roosevelt County, Montana, will be opened at 2:00 P.M., April 3, 1953, in the office of the Superintendent, Fort Peck Indian Agency, Poplar, Montana. Specific information in connection with this sale of leases may be had by letter or wire to James D. Crawford, Superintendent, Fort Peck Indian Agency, or by phoning 2161, Poplar, Montana.

## LEGAL

Sealed bids on Oil and Gas leases on 33,980.85 acres of Tribal and Allotted Indian lands on the Fort Peck Indian Reservation, Valley and Roosevelt Counties, Montana, will be opened at 2:00 P.M., March 27, 1953, in the office of the Superintendent, Fort Peck Indian Agency, Poplar, Montana. Specific information in connection with this sale of leases may be had by letter or wire to James D. Crawford, Superintendent, Fort Peck Indian Agency, or by phoning 2161, Poplar, Montana.

## LEGAL

U. S. DEPARTMENT OF THE INTERIOR, BUREAU OF LAND MANAGEMENT, Washington 25, D. C. Notice is hereby given that 120 acres of land in T. 21 N., R. 16 W., La. M., Louisiana, within the known geologic structure of the Caddo field, will be offered in one parcel for oil and gas leasing through competitive bidding to the qualified bidder of the highest cash amount per acre, at 1 p. m., Eastern Standard Time, April 8, 1953, when bids will be opened. Details of the lease offering, how and where to file bids and a description of the lands may be obtained by addressing an inquiry to this office. Marion Clawson, Director.

# WHY

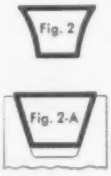
# Gates V-Belts Wear Longer-

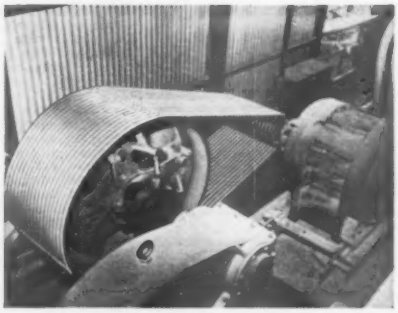
## The CONCAVE SIDE (U.S. Patent No. 1813698) is what gives the Extra Wear!

Take any *straight-sided* V-Belt (Fig. 1) and bend it as it bends in going around its pulley. You will clearly see its sides *bulge out* (Fig. 1-A). These sides therefore press *unevenly* against the V-pulley and this causes extra wear at the point shown by arrows (Fig. 1-A).

**Now bend a Gates Vulco Rope with CONCAVE SIDES (Fig. 2).**

You will see the precisely engineered CONCAVE SIDES fill out to an exact fit in the sheave-groove (Fig. 2-A). The sides press *evenly* against the V-pulley. All wear is distributed *uniformly* across the *full width* of the Gates Vulco Rope—and this means longer belt *life* and *lower* belt *costs* for you.



Typical Gates Vulco Rope Drive—the Gates V-Belts are built with Concave Sides to insure longer belt wear.

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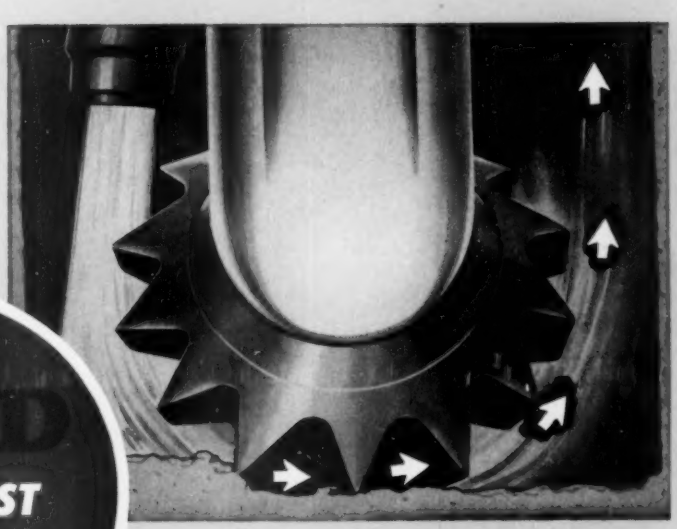
# SWEEP IT CLEAN...
## for faster drilling and more hole per bit



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**REED** Twin-Blast Rock Bits use the full energy of the mud stream to sweep the bottom of the hole clean. Powerful streams of drilling fluid blast cuttings up into the return mud stream.

This better bottom hole cleaning action means cutters are always working on virgin formation. This results in faster drilling, more footage per bit and lower drilling costs.

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**HOUSTON 1, TEXAS**

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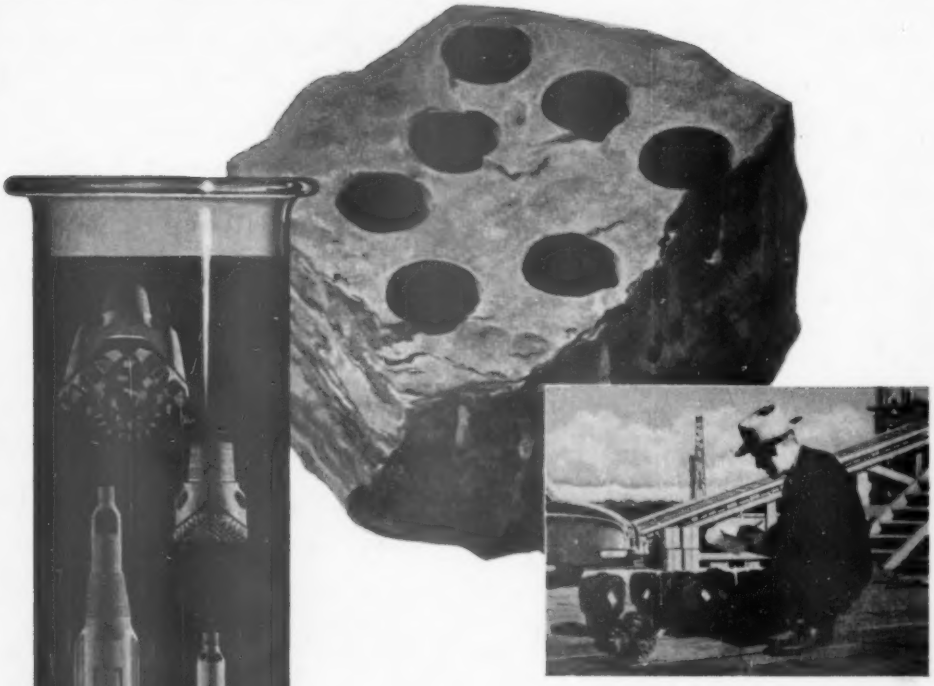

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We've never made a rock bit that completely satisfied us . . . and we never will, although we have made millions of bits. One improvement has invariably led to others, opening new frontiers for research and progress. As a result, record breaking bits of not too many years ago have become today's museum pieces.

Through the years Hughes Tool Company's expenditures in research and engineering to improve the performance of its bits and advance rotary drilling have run into millions of dollars. Currently, these expenditures are at a rate of more than $1,500,000 per year.

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